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A Modern Suction Producer Gas Engine Plant

ISOLATED GAS POWER PLANT IN CHICAGO'S LARGEST TYPE FOUNDRY

SO QUIETLY HAS IT been done that few people, even in Chicago, know that within the last 6 months there has been erected in that city one of the largest type foundries in the world. Not only is it big, but it is built probably with more attention to efficiency, convenience, more and better sanitary and health preserving and safety first appliances than any other plant in the city. This is the great type foundry of Barnhart Brothers and Spindler, located at the northwest corner of Throop and Monroe streets, and shown in Fig. 1.

The ground plan is 200 by 236 ft. and contains about 46,000 sq. ft. of floor space. Its south exposure fronts the pretty little breathing spot known as Jefferson Park. The construction of the building is solid and substantial and although practically indestructible by fire, it is nevertheless supplied with and protected by an effective sprinkler system and fire protection apparatus. Its 2 stories and basement, containing over 100,000 sq. ft. of floor space, house the many departments of a complete type foundry and factory for the manufacture of printers' supplies.

The power plant proper, which is located in the basement, 26 ft. below the street level, may be said to be divided into 3 distinct departments, namely: the boiler room, which contains 2 gas fired low-pressure heating boilers, the producer room and the engine room. Of these three, in this particular plant, the boiler room is of the least importance, as it is only an auxiliary.

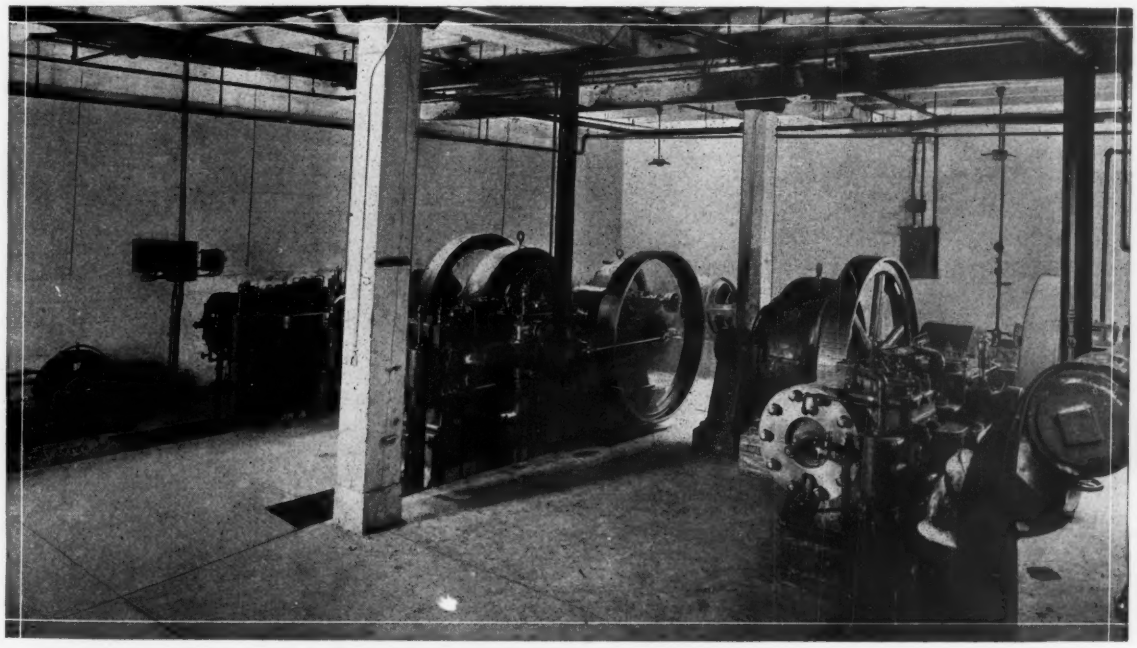


FIG. 4. GENERAL VIEW OF ENGINE ROOM

Producer Equipment

About 15 ft. below the engine room floor is the sub-basement, in which are installed 2 anthracite suction gas producers rated at 350 hp. each and supplied by Flinn and Dreffein of Chicago, together with an auxiliary steam boiler and scrubber, also from the above firm. The depth of the sub-basement is such that the charging cones are on the level with the engine room floor.

The 2 generators in this installation consist of heavy steel cylindrical shells, lined with fire brick, are set in a concrete pan and supported by legs. No grate is provided as the ash and fuel column rests upon the bottom of the concrete pan. A clearance of about 12 in. all around the bottom of the shell and floor of the pan permits accessibility from all sides for the removal of ashes. A water seal is carried in the pan to a level of about 4 in. above the bottom of the shell, and air and steam for combustion are supplied uniformly over the area of fuel by means of a cast-iron tuyere.

When leaving the generator, the gas has a temperature of about 1200 deg. F. and to reclaim a portion of this heat, which would otherwise be lost, the gas is made to pass through an economizer, which consists of an inner and outer shell forming 2 chambers. Gas passes down through the inner chamber, giving up its heat to the air in the outer chamber, which is used to support combustion in the generator. This air is first passed through the economizer by means of a pipe connection leading from the top of the outer chamber to the bottom of the generator, and thus is preheated.

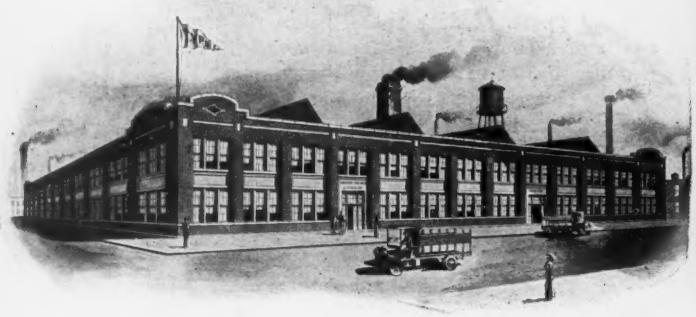


FIG. 1. NEW TYPE FOUNDRY OF BARNHART BROS. AND SPINDLER

In the pipe connection leading from the outer chamber to the bottom of the generator, is a steam blower, such as is frequently used in connection with forcing draft under boilers, this blower being used as a means of saturating the air and neutralizing the pressure in the generator caused by the suction of the exhauster. In the economizer, the sensible heat of the gas raises the temperature of the air to about 500 deg. F.

An automatically controlled regulating device opens or closes the inlet valve of the steam blower according to whether the load increases or decreases. In this way, a uniform quality of gas is generated at all loads.

As it leaves the producer, gas passes through a 3-way water-sealed valve and into the main header. The third opening of the 3-way valve is connected to the atmosphere. In starting, the producer smoke and gases cannot escape and therefore must be diverted out of doors. When once started, the 3-way valve is closed and the gas produced is drawn into the main header. This header leads to the scrubber, from which one line is taken to supply the engines and another used to furnish gas to the factory for manufacturing purposes.

The scrubber, the duty of which is to remove soot, tar and other impurities from the gas, consists of a heavy steel cylindrical tank, high in proportion to its diameter, with a coke column, supported by trays, extending to within about 5 ft. of the top. Above the surface of the coke are located water sprinklers, and over these, between 2 trays, is a layer of excelsior. Gas, passing upward in a zig-zag course through the coke, comes in contact with the water freely supplied by sprinklers from above. The water mixes with the gas and drives down the impurities, causing them first to adhere to the rough surfaces of the coke and then drop with the flow of water. Gas, passing through the excelsior at the top of the scrubber, is freed of moisture that has become mechanically mixed with it. The coke column is divided into several sections, according to the height of the scrubber, and between each of the sections is a manhole, so that access may be had to any one of them. Manholes are also provided so that the excelsior may be replaced when desired.

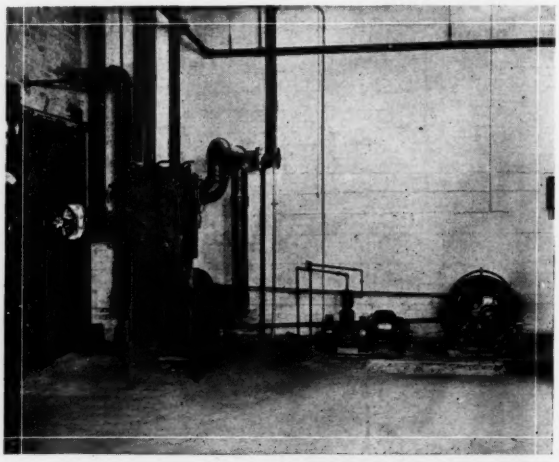


FIG. 3. MOTOR-DRIVEN EXHAUSTER; SMALL MOTOR-DRIVEN AIR COMPRESSOR IN CENTER

From the scrubber the gas is led to the exhauster, and thence distributed. Figure 2 illustrates the charging floor of the producer room.

Figure 3 gives a view of the motor-driven exhauster and also of a small Gardner and Sons air compressor. This compressor is geared to a 3-hp., Crocker-Wheeler, direct-current motor and is used for supplying air for starting purposes. This air is pumped into 2 reservoirs and is maintained at a pressure of 200 lb. per sq. in.

The producer air supply is created by a steam jet producing a partial vacuum in the supply line, this steam being supplied by the small vertical boiler mentioned above.

Connected with the producer room at the lower level, is a pump room containing the bilge, the roof tank and the circulating pumps used to supply water for the cooling of the type and the lead casting machinery, as well as the engine cylinders.

Coal Handling Equipment

No coal is in evidence in the producer room, as no more than the amount required for each charge of the producer is brought in. A 100-ton gravity feed coal bunker is situated outside of and adjoining the producer room and by means of a chute leading therefrom, the coal carrier is readily filled. This carrier is raised by an electric hoist traveling upon an I beam supported between 2 opposite walls. All that is required to fill the producer is to let the carrier down under the chute, allow the coal to run in, and raise it by means of the electric hoist. Upon reaching the level of the producer room floor, it can be easily pushed along the supporting I beam over either one or the other charging door. The simplicity of this system and method of operation is such that one man can easily charge the producers and at the same time look after the operation of the engine room.

The ash from the producer must be shoveled out at the bottom through a water seal.

Near the scrubber and within plain sight of the operating engineer are a sampling flame and 4 manometers to determine the quality and pressure of the gas.

Engine Room Equipment

The 2 main generating units are a single Alberger tandem gas engine directly connected to a 75-kw., 250-volt Crocker-Wheeler direct-current generator, and a double Alberger tandem gas engine driving a similar generator of 150 kw. Both engines, which are illustrated in Fig. 4, have cylinder dimensions of 17 by 16 in. and operate at 250 r.p.m.

The cylinders of these engines are placed horizontally and are arranged in tandem, similar to tandem steam engines. The cylinders are single-acting and operate independently but similarly.

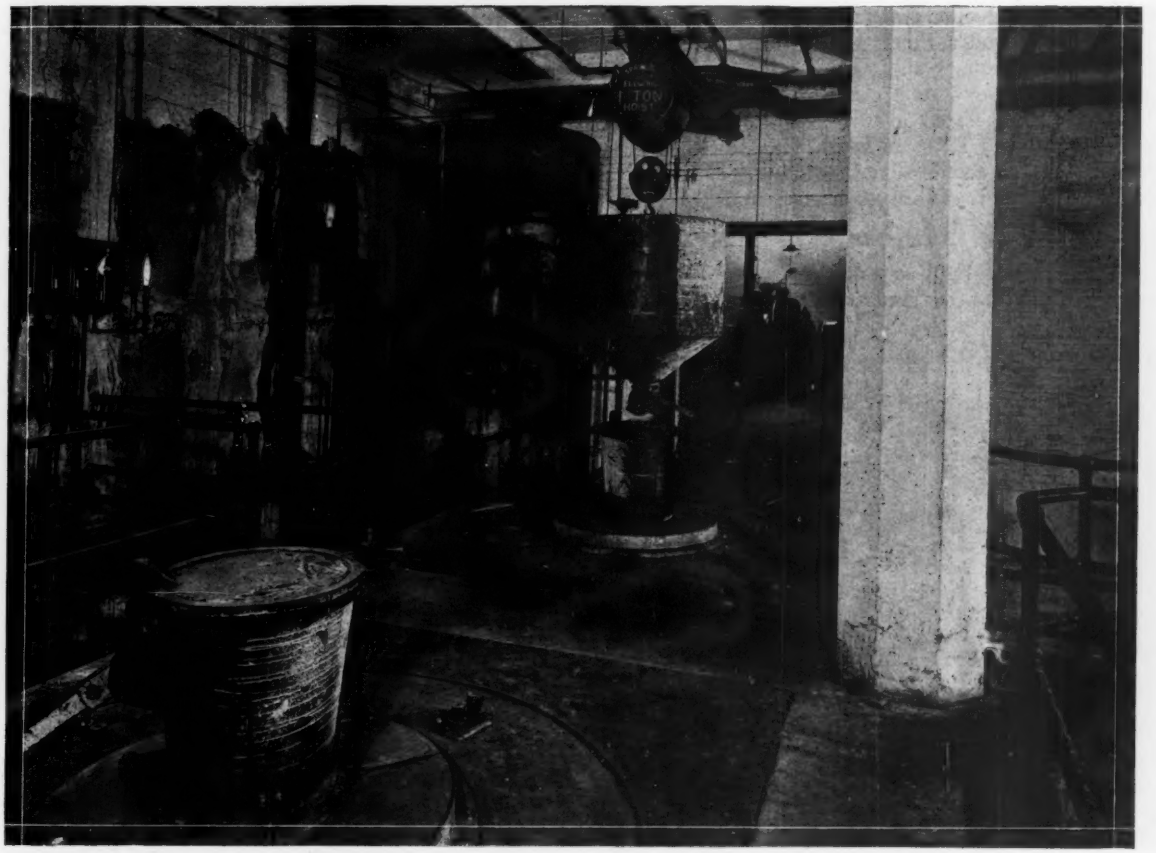


FIG. 2. PRODUCER ROOM, SHOWING CHARGING CONES AND SCRUBBER

The standard 4-stroke cycle is used, the cycle beginning with the engine on the back center. While the 4-stroke is continuously repeated in each cylinder, the periods of the cycle are not simultaneous in the 2 cylinders, but are spaced one revolution apart. Thus, if the expansion stroke or power stroke is occurring in one cylinder, an admission stroke is occurring in the other cylinder; if compression is occurring in one cylinder, the exhaust gases are being expelled from the other during the same stroke. Taking the 2 cylinders in conjunction, every forward stroke of the engine, or ½ of every revolution, is a power stroke, which results in steady operation well fitted for electrical service.

Admission and exhaust valves of the engines are of the poppet type and are actuated by a simple cam and lever movement. The cams are keyed to the cam shaft,

which is supported by 3 adjustable bearings and is driven from the cam shaft by a pair of helical gears.

Automatic cutoff regulation is employed, the cutoff valve being actuated by a Rites inertia governor, holding the valve open for a part of the stroke, and then closing it quickly, earlier or later in the stroke, according to the load on the engine.

An interesting feature of these engines is the double ignition system, each cylinder being equipped with 2 independent and complete electric ignition systems of the jump spark type, with 2 spark plugs. The current to one spark plug in each cylinder is supplied directly from a slow-speed magneto for starting and running the engine. The second system, which consists of cells, vibrator coils and a timer, is used only as a relay for the magneto system, and can be thrown into service instantly. Either system can be operated or both systems can be operated at the same time. With both systems switched in, some spark plugs on each system may be out of commission in different cylinders, and yet the ignition is continued in all cylinders.

Auxiliary Units

For factory lighting purposes, a 3-wire system is employed and to be used in connection with this is installed a 125-volt, 50-amp., Crocker-Wheeler balancer set, running at 1650 r.p.m.

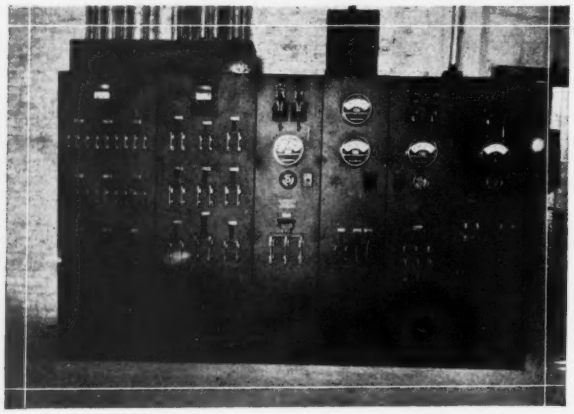


FIG. 5. GENERAL VIEW OF SWITCHBOARD

As all of the generating units are of the direct-current type, a 75-hp., 230-volt, 273-amp. motor generator set is used for the necessary supply of alternating current, which is employed for welding purposes only. The direct-current end of this set is a Crocker-Wheeler motor rated at 75 hp. at a speed of 1050 r.p.m., while the alternating-current generator is made expressly for welding purposes by the Thomson Welding Co., of Lynn, Mass.

In connection with the sprinkler system, there is installed on the engine room floor a combined air and water pump, manufactured by the Lucas Pump Co., and direct-connected to a 5-hp. Sprague Electric Co. motor.

The Switchboard

Six panels of black slate mounted upon a frame of angle iron construction, comprise the switchboard equipment, which was installed by Henry Newgard & Co., of Chicago. The first panel is used to control the welding set and consists of a 5-point starting switch for the direct-current side, a 2-pole, single-throw knife switch for throwing onto the alternating-current line, a 0 to 600-volt Weston voltmeter and 2 Condit Elect. Co. 200-amp., 500-volt plunger type circuit breakers. The second panel consists of one 3-pole single-throw knife switch, field rheostat, one 0 to 500-amp. Weston ammeter, 2 200-amp., 220-volt Condit circuit breakers and the necessary synchronizing receptacles. The balancer panel comes next, with its single 2-pole single-throw knife switch, one single-pole single-throw neutral switch, one single-pole single-throw starting switch, one 150 to 0 to 150-volt Weston differential ammeter, one 0 to 300-volt Weston voltmeter and synchronizing receptacles. Last of the machine panels is that of the 150-kw. generator, which carries one 3-pole knife switch, field rheostat, one 0 to 1000 Weston ammeter, 2 600-amp. 220-volt Condit circuit breakers and synchronizing receptacles.

The last 2 panels are for distribution service and are provided with the necessary 2 and 3-pole single-throw knife switches. Each distribution panel has its totalizing integrating wattmeter. Figure 5 is a general view of the board.

For the purpose of starting up the exhauster in the morning and for the operation of the various pumps throughout the night, local central station service is available at the rear of the board.

C. G. Dreffein, of the Flinn and Dreffein Co., Chicago, had charge of the erection of the production plant, while W. S. Jones installed the gas engines. The plant is now in successful operation under the supervision of Emil Oertlin, of Chicago.

Some figures given by J. E. Starr, before the Eastern Ice Association, on the Cost of Ice Manufacture, are of interest. For the first plant, which was of 50 tons capacity, with coal costing $2.85 a ton, and condensing water at about 71 deg., the cost of coal per ton was 29.5 cents; labor, including repairs, 35.6 cents; ammonia, 1.5 cents; city water, 4 cents; oil and material for repairs, etc., 2.7 cents, or a total manufacturing cost of 73.3 cents. The assumed fixed charges, including taxes, insurance, reserves and charges on buildings, amounted to 58.4 cents a ton, or a total of $1.317 a ton as shop cost. Added to this would have to be the administration expense, salaries, delivery, selling cost, etc. The plant, which was located in New York City, including the site, cost $95,000, and storage capacity was provided for 160 tons of ice.

In a second plant, which was of 42 tons capacity, on the absorption system, making plate ice and operating continuously throughout the year, the temperature of the water was 60 deg., the coal cost was 23.6 cents per ton of ice; labor cost, 35.45 cents; oil and waste, 2.1 cents; ammonia, which had high cost, due to leaks in the piping system, 13.37 cents, and repairs, which were high because of the necessity for fixing up the leaks, 11.4, or a total of 85.92 cents a ton for manufacturing cost. The investment in this plant was a total of $84,000, and fixed charges were taken at 46.45 cents a ton, making a total cost of $1.3237 a ton.

Modern Boiler Room Practice*

REQUIREMENTS FOR PROPER COMBUSTION IN BOILER FURNACES; FURNACE VOLUME; BOILER RATINGS; PURCHASING COAL. BY CHARLES H. BROMLEY

CONSIDER a boiler as something of 2 distinct parts, a furnace, where combustion of the fuel takes place to produce heat, and a shell containing water to absorb that heat and furnish steam. Successful boiler operation lies in getting as much of the heat in the fuel into the water in the shell as is practically possible. Consider the 2 parts of a boiler as distinct, because you may have the best possible furnace efficiency, while the heat-absorbing efficiency of the heating surface may be extremely low, due to scale and soot accumulation.

EXCESS AIR

THEORETICALLY, 11.6 lb. of air are required to burn 1 lb. of coal. Practically, 20 to 24 lb. are needed. The difference between 11.6 lb. and 24 lb. is the excess amount—excess air. From 25 to 45 per cent excess air must be admitted to the furnace to obtain complete combustion and the heat it is possible to produce.

The greatest of the heat losses result from the following causes: Too much air admitted, even though it is well mixed with the gases. The draft may be correct for normal conditions, but owing to the presence of a proper combination of iron, silica, lime, sulphur and clay in the fuel, the coal may clinker and slag, stopping the admission of the proper amount of air through the grate. Then CO instead of CO_2 will form and about only ⅓ of the heat will be obtained from the same amount of fuel burned properly to CO_2.

As for draft, we are interested chiefly in the volume of gases passing over the heating surface, because on this depends, almost solely, the rate of steam production, provided we have apportioned the air supply correctly and the boiler is clean. Therefore, for a given fuel and grate we can determine the thickness of fire and the boiler draft (pressure difference between the furnace and uptake) that will give the best results for a given load. This condition of fuel bed and draft must be determined for each load condition on each boiler.

Coals of different constituents require different amounts of air. Every shipment of fuel varies in quality and constituents. Many firemen turn the fire upside down and mix much ash with the white-hot coal every time they use the slice bar. The ash melts and by the time it reaches the grate, it has cooled and formed slag and clinker, increasing the resistance of the fuel bed.

Too much is expected of the fireman. His duty is well done and ends when he maintains the correct height of and a level, even-burning fire, regulates the draft to suit the load and fuel conditions, maintains a uniform water level and keeps soot out of the boiler. The fireman must use some judgment, but the fuel and load conditions in nearly every plant admit of finding what furnace adjustments are needed. Find what these adjustments are by closing all air leaks in the setting and its doors and the boiler headers, and analyzing for CO_2 until the thickness of fire and draft that will produce the highest CO_2 and still make the boiler do its share of steam making is found.

If the settings are scraped and painted, first use a thin mixture of fire clay or cement, or preferably both, and let the bricks soak all they can. If an asphaltum-base paint is used, be sure to get one that will not run at the temperatures dealt with. Asbestos board, covered with canvas and painted, makes a good final covering if cared for properly.

Any CO_2 recorder is a delicate instrument and to prove successful, must have some 1 or 2 responsible individuals to care for it.

SOOT

SOOT WORKS a 3-fold harm. It lowers the heat absorbing efficiency of the heating surface. It obstructs the gas passages through the tubes, which necessitates more draft for a given steaming rate. It contains more or less sulphur and if the soot gets wet from leaks, sulphurous and sulphuric acids are formed, causing corrosion of the tubes.

Stoppage of gage-glass and blowoff pipes must be guarded against, as the former trouble has led to some disastrous explosions.

FURNACE VOLUME

IT SEEMS strange that, after all that has been said of the value of high settings, or large furnace volume, there should be so few in new boiler installations. The only losses are those by radiation and air infiltration, which are negligible, for both may be reduced to a minimum. Combustion will be complete before the heating surface is reached and high furnace temperature may be maintained. High volatile and cheaper coal may be used to advantage. Slow gas velocity in the furnace, with comparatively high combustion rates, is possible, and fine coal may be burned without a large percentage of it being carried over the bridge-wall or to the tubes and stack. The cost of high settings, and possibly of higher buildings required for them, is many times offset by the reduction of heat losses over low settings.

At the South Boston station of the Boston Elevated Railways Co., the B. & W. boilers are 8 ft. above the stoker grate at the rear. At the 201st St. Station of the United Electric Light & Power Co., New York City, they are 10 ft. above. At the Delray station of the Detroit Edison Co., the gases travel 28 ft. from the underfeed stokers before they strike the heating surface. An 84-in. by 18-ft. horizontal tubular boiler at the plant of the North Newark Cold Storage Co., Newark, N. J., is 72 in. above the grate. The lower row of tubes in the double stoker boiler at the 59th St. power house of the Interborough Rapid Transit Co., are about 12 ft. from the stoker set under the rear of the boiler. High settings are as advantageous in small as in large plants.

* From a lecture before Newark (N. J.) N. A. S. E.

The ideal condition, and one that can be closely approached, is to have the setting high enough so that no visible flame will be noticed touching the heating surface, even under reasonably high ratings. The flame should consume itself before leaving the combustion chamber.

Combustion Rates

Next to heat losses by excess air due to leaky settings and improper firing, are those due to combustion rates far below the capacity of the boiler. Comparatively few plants are not subject to this usually inexcusable practice. Rated boiler capacity is totally disregarded in good operating practice. It is good as a guide in designing and buying, but there is not much use for it in operating.

The boiler room represents a large part of the total power plant investment. When boilers are run far below rating, the loss is double. Interest, insurance, depreciation, all large items in boiler practice, must be charged against all boilers in excess of those actually needed for the steam requirements and those needed for reserve or emergencies. In addition to this, the investment for those boilers not really required may be considered a nearly complete loss unless a corresponding increase in steam capacity will be needed soon after the initial installation.

The other loss is a heat loss. As boilers are run below capacity, the excess air admitted increases rapidly, and the losses due to low CO_2 are too well known to be discussed here. Maximum boiler efficiency is nearly always obtained at a rating much below normal. The drop in efficiency is quite small for ratings as high as 200 to 300 per cent. Where peak loads must be handled, it might and often would be more economical to operate the boilers at 200 to 300 per cent rating for a few hours to carry the peaks, than to carry banked fires under standby boilers. This practice admits of greatly reducing the heavy overhead charges in the boiler room, which are such large factors in the unit cost of power.

The day is not so distant when a far greater ratio of prime mover capacity to that of the boiler will prevail in manufacturing plants, especially plants subjected to peak loads. This practice is being vigorously followed out in large central stations and railway power houses. The table herewith shows the trend in such neering practice.

STOKERS, COAL AND KILOWATTS PER BOILER HORSE-POWER IN LARGE PLANTS

Plant	Kind of Stoker	Kind of Coal	Kw. per Boiler hp.
Delray - Detroit Edison Co.	underfeed	bituminous	norm. 4.22 emerg. 5.65
201st St., New York City	underfeed	80% hard, 20% soft	4.7
59th St., New York City	underfeed and chain grate		4.2
Waterside No. 2	underfeed	80% hard, 20% soft	4.2
L St., Boston Edison Co	underfeed	bituminous	4.
So. Boston - Boston E. R. R. Co	underfeed	bituminous 18% volatile	3.75
N. W. Sta., Chicago, Comm. Edison Co.	chain grate	bituminous	3.46
Waterside No. 1	underfeed	80% hard, 20% soft	3.3
Marion, Jersey City, P. S. Corporation	chiefly underfeed	bituminous — 24% volatile	3.

Owing to future growth or other local conditions, overhead charges on the boilers installed to care for the future demands are unavoidable. The overall expense is needlessly increased when all the boilers are run considerably below rated capacities, as is so common a practice. Wherever possible, building and equipment foundations should be put in, and as the demand compels, extend the building and equipment accordingly.

Troubles Due to High Ratings

Deterioration of furnace walls and stokers is considerably greater at high than at low ratings. In some plants, the question of how much firebrick per unit of delivered steam one can afford to burn, determines the boiler ratings.

Engineers who favor high ratings may carry the practice too far and thereby get into serious trouble. It must be remembered that extreme high ratings are not possible in every locality, and that even though the circulation of the water in the boiler is perfect at the highest ratings, the scale forming salts and the suspended matter in the water are the factors that determine how high the rating may be safely carried. A word of caution, therefore, is necessary to check, before it really begins, an extremely dangerous practice. Do not forget that, in the best of practice, boilers run at high rates are so run for very brief periods; not longer than an hour-and-a-half at the most.

It will be found to be cheaper and to promote better service to install the adequate number of boilers and run them at a rating that is, first, safe, and, secondly, that will most reduce the overhead or investment charges.

The brick walls in modern boilers do not support more than their own weight, and this makes possible much higher combustion rates than if these walls were loaded. Brick that expands too much will surely cause the walls to bulge. The inspection of the setting must be as thorough as that of the heating and steam surfaces when high rating obtains.

Tube Troubles

Experience shows that with clean tubes and good circulation the water will absorb the heat as rapidly as it is practicable to supply it. The danger lies in scaled tubes or scaled and muddy tubes. At high rating, therefore, thorough care must be taken to precipitate suspended matter and neutralize the scale-forming solids, especially those that form sulphate scale.

Corrosion

The electrolytic is the most widely accepted theory of corrosion. Briefly, it is this: The substances composing the metal are not intimately and thoroughly mixed and distributed. Electrically, some substances are negative and some are positive. The water or dampness covering the metal acts as an electrolyte to set up a flow of current between one positive substance and one negative one. The metal goes into solution at the point from which the current flows and pitting begins. Experience indicates that pitting is often started at places on the plate where pieces of scale or other foreign substances have deposited.

Boilers left full of water while out of service often suffer from external corrosion, because the cool heating surface condenses the vapor in the air, the vapor covering the surface which soon corrodes. Corrosion from wet soot has been mentioned.

Where creek and river waters are used, and especially if the streams drain coal, iron or other mining districts, corrosion will usually be severe. In the spring, when the snow melts, much acid is carried by the waters that drain mining districts, and often the water must receive special treatment during this season. "Home" remedies are not to be recommended for such conditions. Be sure to inspect closely for corrosion where tubes enter the heads or headers.

If a plant designed for saturated steam is to use superheated steam, stop valves and gaskets should be adapted to the new conditions at the time the superheaters are installed. Failure to do this has turned 75 per cent of the operating engineers emphatically against superheated steam.

Where coal costs more than $3 a ton and the plant's capacity is reasonably high, the value of economizers is unquestioned. Small plants will not find them advantageous unless the exit gases are of a very high temperature or the water is used for industrial purposes.

Automatic stop valves should be considered as necessary as safety valves. In preventing a shutdown of all boilers in case of accident to one, they would save far more than their cost.

Purchase of Coal

Cost of coal in any kind of plant will be between 55 and 75 per cent of the total power cost. An average in well conducted plants, favorably located, will be 65 per cent. The chief reasons for scientific methods of purchasing are, therefore, sound, even though power cost in manufactories is only 2 to 7 per cent of the total cost.

No statements are necessary to convince one of the value of buying coal on specification, but much needs to be said of the character of the specifications.

Purchase of coal on a strict British thermal unit basis is wrong to dealer and user. The heat value in British thermal units may be high, but the fuel may be so unsuited to furnace and grate that it would be prohibitive.

Coal should be purchased on a basis fixed by the value of the fuel to the plant and not on its British thermal unit or ash content. Coals giving very good evaporation results may so clinker and slag as to be intolerably troublesome to burn. When coal is bought on an evaporative basis, therefore, the contract should contain a clinker and slag clause, besides those relating to slate and bone; otherwise a prolonged dispute will arise. It may or may not be possible to get a reduction in price for the contractor has the advantage of having met specifications as to evaporation results.

System of Induced Draft

Method of Using a Stack of Venturi Tube Form, with Diffusing Nozzle and Light-Weight Fan, to Increase the Capacity of the Boiler

THIS system, which was devised by Louis Prat, some 20 yr. ago, has come into rather extensive use in Europe, and is being adopted in a number of plants in Great Britain. The essential features are, the use of a double-tapered chimney, and a fan which does not take all the gases from the boiler, but which may be arranged to cause a draft on the inspirator principle, using either outside air or a part of the flue gases, as may be desired. The data are taken from Engineering.

Details of the Stack

From the illustrations it will be seen that the chimney, which is of steel throughout, has a parallel part at the lower end where it joins the flue, and above this is tapered to a narrow area, and then tapers in the reverse direction to a maximum at the top of the stack. In the center of the chimney, just below the narrowest part, is fitted a nozzle connected to the fan, the blast through this nozzle causing a suction in the lower part of the chimney. The object of the taper is to give increased section for the outgoing gases as they leave the chimney, thus decreasing their speed, and reducing the pressure at which the gases are discharged into the atmosphere, thereby lessening the work required of the draft system. In one method of use, the fan draws its air from the outer atmosphere, and in the other it is placed as a shunt to the flue, drawing in and discharging into the narrowest portion of the stack, a part of the flue gases. The arrangements are known respectively as "out of circuit" and "in circuit" systems, the "in circuit" having the advantage that, as chimney gases are not diluted by external air, there is less volume to handle and a smaller chimney may be used than with the "out of circuit" type. The disadvantage of the "in circuit" is that the fan must handle hot flue gases; but in the Prat system, the mechanical difficulties have been reduced to a minimum by careful design. In practice, the "out of circuit" system is used mainly for small installations, where there would be little saving in power by the use of the "in circuit," which is more commonly employed in large plants. Under similar operating conditions, the "out of circuit" system takes about 25 per cent more power than the "in circuit."

Figures 1 and 2 show 2 types of nozzles, in the first, a simple nozzle being employed, and in the second, a diffuser. In both instances, a small right-angle bend will be noticed entering the stacks from the left, this being for a steam jet which is used in case the fan or its motor is disabled, and may also be used as an auxiliary to assist the fan during any overload. Ordinarily, the steam jet is used only as a stand-by. When using the steam jet, the effectiveness is greatly increased by the use of the internal diffuser, as shown in Fig. 2.

Diffuser Nozzles and Dampers

Use of this internal diffuser also increases the efficiency of the fan air jet. The effectiveness of the inspirator depends upon intimate contact between the flue gases and the air jet, and by using the internal diffuser and giving this jet a ring form, the proportion of air supplied by the fan, which comes into effective contact with the flue gas, is increased, so that better draft may be produced by a given fan, or for a desired draft a smaller fan may be used. The use of the diffuser applies equally to either "out of circuit" or "in circuit" arrangement.

This stream-line motion, produced both by the shape of the stack and the form of the damper, is one of the strong features in giving the effectiveness which is found in the Prat method of draft.

Figures 3 and 4 illustrate the saving in chimney size which may be effected by the use of the "in circuit" system, as compared with the "out of circuit" system.

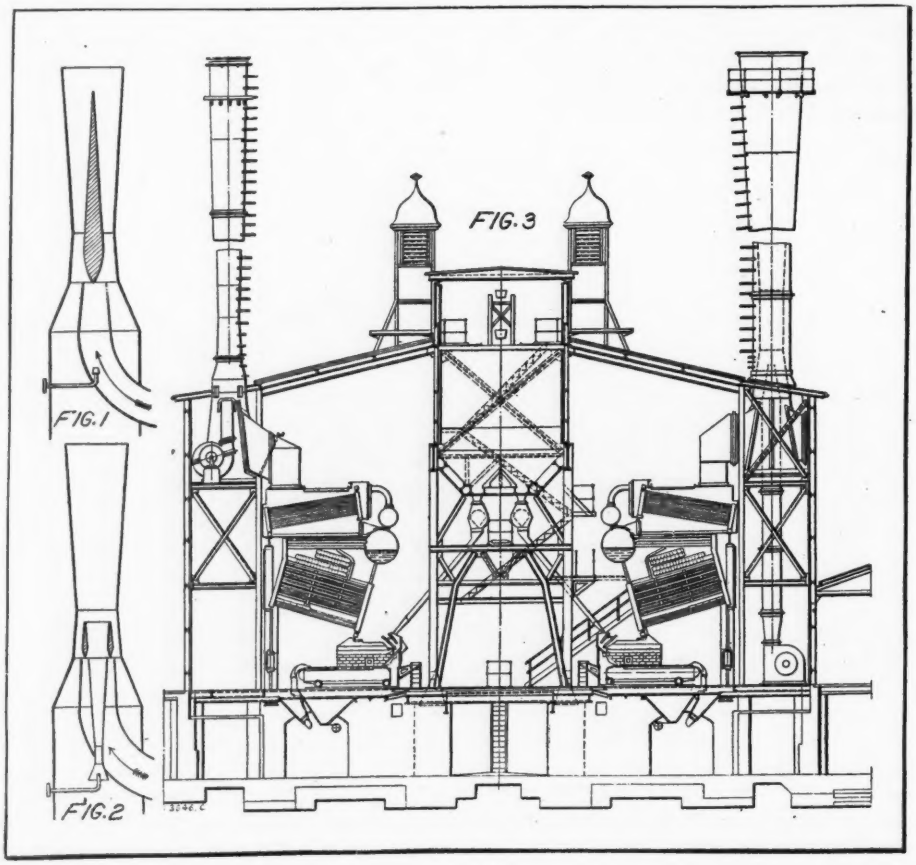


FIG. 1. NOZZLE FOR PRAT SYSTEM, WITHOUT DIFFUSER
FIG. 2. PRAT SYSTEM NOZZLE WITH DIFFUSER AND ANNULAR DAMPER

FIG. 3. CROSS-SECTION OF POWER PLANT, SHOWING "OUT OF CIRCUIT" AND "IN CIRCUIT" METHOD OF INSTALLING THE PRAT SYSTEM

In both Figs. 1 and 2, the damper is seen above the fan nozzle. This damper is not a door or flap, as is common in stacks, but is a plug, which can be lowered to reduce the size of the opening through which the air or gas from the fan enters the chimney. By comparison of Figs. 1 and 2, the size damper necessary with and without the diffuser is seen; that with the diffuser being much smaller, therefore cheaper and easier to operate, and likely to be used to the best advantage by the attendant. These dampers are used only when the fan must be driven at constant speed, as when it is operated by belt or by a 3-phase motor; with a fan driven by direct-current motor, the speed of the fan can be varied according to the draft desired. The shape of the damper should also be noticed, as this is such as to give the least resistance to the flow of gases past the damper, and the curved and tapered form prevents the formation of eddy currents in the gases.

The boilers on the right in Fig. 3 have "out of circuit" fans, while those on the left have "in circuit," the right-hand installation being the older, and the difference in size shows the saving in size of stack required. Figure 4 is a photograph of the same installation, which is in the Electric Central Station at Sampierdarena, Italy.

Fan Details

By the "in circuit" method and the use of the inspirator, the fan employed is of relatively small capacity, being only about 1/5 the size necessary if the fan handled the whole volume of gases. Efficiency in practice is secured of from 60 to 75 per cent, the details of

the fan being as shown in Fig. 5. Because of handling hot gases, the fan is of strong construction, with blades of heavy material, and arranged to be easily replaced. The inner bearing is of necessity cooled; but here an air

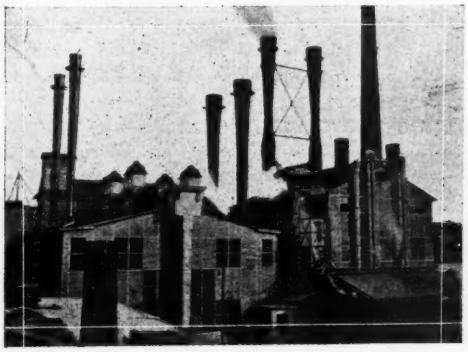


FIG. 4. INSTALLATION OF PRAT DRAFT SYSTEM AT SAMPIERDARENA

cooling system is employed instead of water cooling, the small blades shown at the right of the fan being used to draw air across the bearing and force it outward, thus giving a continuous flow of cool air over the bearing.

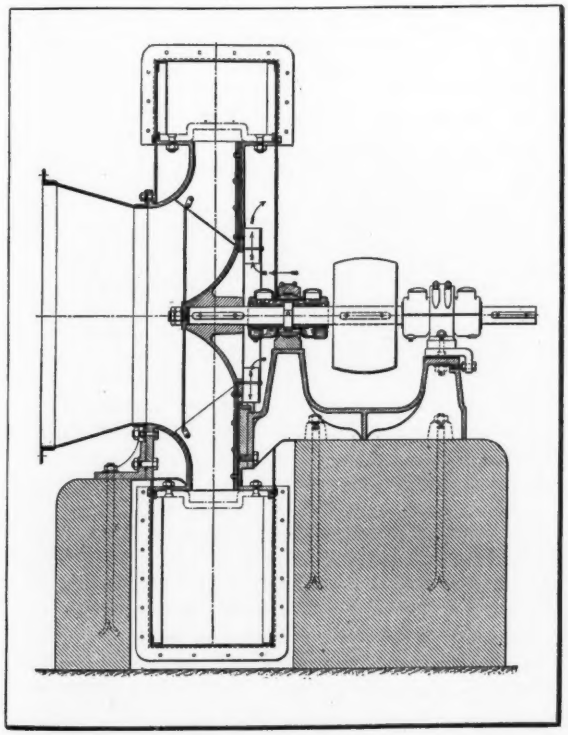


FIG. 5. CROSS-SECTION OF FAN USED IN THE PRAT INDUCED DRAFT SYSTEM

The system adds but little to the power required to operate the plant, the draft necessary for operating the fan being from 0.3 to 1 per cent of the entire power. As an example of the performance of such an installation compared to a natural draft chimney, a mill at Rouen had a brick chimney 148 ft. high replaced by a Prat chimney 49 ft. high, using the same boilers and stokers and the same quality of coal. On a 7 days' trial, the evaporation per pound of coal with the Prat system was 8.164 lb. of water, as against 7.385 lb. for the natural draft chimney. As with any mechanical draft system, the draft is variable according to the load, either by hand regulation or automatic control, up to about 3 times the normal draft value.

Results from tests of a boiler equipment having a chimney 21 ft. 6 in. high, as compared with a natural draft chimney 65 ft. 6 in. high, under the same working conditions of 71 lb. boiler pressure, showed an increase of fuel consumption from 850 lb. up to 1650 lb., the consumption per square foot of grate increased from 18.4 lb. up to 30.6 lb., water evaporated increased from 6150 lb. up to 14,000 lb., and the evaporation per pound of coal increased from 7.26 lb. to 8.53 lb. Analysis of the fuel showed that it was practically the same for both tests, and analysis of the flue gases showed 5 per cent to 7 per cent carbon dioxide for natural draft, and 10 per cent for the induced draft.

It will be seen that the Prat system is simple, and it is also light and inexpensive, the chimney being self-supporting and requiring no guy rope. In many cases, the system is mounted directly above the boiler, as indicated on the left-hand side of Fig. 3.

How the CO_2 Recorder Helps

WITH the indicating and recording dial placed at the boiler front, where the fireman can watch it, the recorder helps him to fire more efficiently, that is, to keep up the steam pressure with less coal, hence saving him labor, and because it keeps a continuous record of his good work and puts it before the superintendent, it shows that he is working efficiently, and gives a convincing argument for increased pay or a better job.

To the superintendent the recorder comes as a friend, because it gives him important information which can be obtained in no other way, and because this information is recorded continuously without special effort, and free from any personal influence or liability to deflect. The records will enable him to "weed out" careless and inefficient firemen with certainty, and to recognize efficiency and do justice by increasing pay and promotion. Also, the records will show deficiencies in boiler settings, leaks, etc., which otherwise might be undiscovered for months, and in this way will generally result in a saving of 20 per cent, and always in a substantial saving in the cost of operating the boiler house. That such a saving will be worth while for his own satisfaction and for the standing which it will give him with the employer, goes without saying.

Because the recorder is the friend of the man who shovels the coal, and of the man who is responsible for seeing that it is burned economically, enabling the former to do the best possible work, and the latter to select the best men for the work and keep his plant in shape for the most economical performance, it stands to reason that the recorder should receive friendly consideration from the general manager and proprietor. That a sav-

ing of from 5 to 20 per cent of coal consumed can be made, is conceded by every combustion engineer and power plant expert.

With this fact in view, why should the general manager permit, and how can the proprietor afford to leave the fireman without a means of knowing whether he is firing economically or wastefully? Is it good policy to leave the superintendent groping in the dark as to whether the firing is efficient or not, and whether his plant is operating under good conditions or not, when an apparatus can be installed which will indicate what is actually being done on an interrupted record, and will permit the superintendent to employ his firemen on a basis of satisfactory accomplishment, and to regulate their pay and promotion by logical reasoning rather than personal impression? It is common knowledge that an inefficient fireman may waste double his wages in coal, but it cannot be determined offhand whether he is doing it or not. Why should not a record of performance be obtained when it can readily be had, and will serve not only for the regulation of present activity, but as a basis for study and comparison for possible improvement in the future?

Large Turbines on New Cunard Liner

DIMENSIONS, DETAILS AND ARRANGEMENT

IN order to maintain a weekly schedule between New York and Liverpool, the Cunard Co., on May 31, sent out on her trial voyage, its new and palatial ocean liner, the Aquitania, sister ship to the Lusitania and Mauretania.

The machinery of this new boat embodies important departures, notably in the working of the turbines in triple series, the consequent greater range of expansion of the steam being inducive to higher economy. At the same time, ingenuity has been exercised to ensure that the turbines can be worked independently of any which may be thrown out of action. With one turbine out of gear, it will be possible to maintain practically full speed. Another important advantage is the great rapidity with which the ship can be maneuvered and the power available for astern driving.

With 4 screws, there are 2 turbines, one ahead and one astern, on each propeller shaft. On the outer shafts, these turbines are entirely separate; while on the inner shafts, on which are mounted the low-pressure units, the ahead and astern machines are incorporated in one casing with a common condensing connection.

An idea of the enormous size of these units may be obtained from a few interesting figures. The total weight of the low-pressure ahead and astern turbine is 445 tons. The rotor drums are 12 ft. and 10 ft. in diameter, respectively. The turbine is 54 ft. 3 in. long over all from the forward end to the aft coupling. The distance between centers of main bearings is 35 ft. 1⅛ in., and the journals are 3 ft. in diameter by 5 ft. 9¾ in. long, while the rotor spindle is 3 ft. 2 in. in diameter. Nine expansion stages are used in the ahead turbine, and 4 in the astern; in the former, the blades vary from 7 to 20 in. in length, and in the latter, from 5 to 7 in.

For the intermediate pressure turbine, the weight of the rotor is approximately 90 tons. The main bearings are 26 ft. ½ in. between centers and the journals are 4 ft. 4½ in. long. This turbine has an overall length of 41 ft. 6½ in. from the aft coupling to the forward end. Four expansion stages are provided, the length of blades varying from 6¾ in. to 14 in., set on a rotor drum 10 ft. 4 in. in diameter. In the case of the high-pressure astern turbine working on the same shaft as the intermediate-pressure turbine, the design and dimensions are exactly the same as the astern turbine on the same shaft as the high-pressure unit, except that the direction of rotation is reversed. From the aft coupling to the forward end, the high-pressure ahead turbine is 40 ft. 2 in. long over all and the total weight is 240 tons. The main bearings are 25 ft. 4½ in. between centers, while the journals on the rotor spindles at these bearings are 2 ft. 6 in. in diameter and 3 ft. 8¼ in. long. The spindles are hollow, the hole varying from 11 to 23 in. in diameter. The high-pressure ahead rotor drum is 9 ft. 2 in. in diameter and has a weight of 80 tons.

The high-pressure astern unit, which is fitted abaft the high-pressure ahead turbine, is 22 ft. 11 in. over the couplings and weighs 120 tons, the bearings being 17 ft. 7½ in. centers. The journals are 2 ft. in diameter and 2 ft. 7¾ in. long. There are 4 expansion stages, the blades in the first being 1½ in. long, increasing to 3 in. in the third and fourth stages, the final stage being arranged for by the "winging" of the blades. The high-pressure astern rotor drum is 7 ft. 10 in. in diameter and weighs a little over 40 tons.

The arrangement for the efficient lubrication of the main bearings of the Aquitania's turbines is very complete. Each bearing has 2 supply pipes from separate mains—one in the wing and one in the center engine room port and starboard—thus ensuring a supply should either main be rendered inoperative. Six direct-acting pumps, 12½ by 10 by 24 in. stroke of Weirs standard type are fitted; however, only 4 of these are required to maintain the necessary oil supply. The tanks from which these pumps draw the oil are situated at the forward end of the center engine room. An oil strainer is connected with each pump suction and on the discharge side are fitted 4 filters for further cleaning of the oil.

In compliance with the recent practice in ocean liners, the turbines in the 3 separate engine rooms are arranged to work on the triple system. The steam piping is so laid out that under normal working conditions, the high-pressure ahead turbine, which with a high-pressure astern turbine occupies a separate compartment in the port wing engine room, receives direct boiler pressure. From this unit the steam passes to the intermediate-pressure turbine, occupying with a high-pressure astern turbine a similar compartment on the starboard wing. The 2 low-pressure ahead turbines on the 2 inner shafts receive their steam from the intermediate pressure turbines. The high-pressure astern turbine on the port side and the high-pressure astern turbine on the starboard side each receive direct boiler pressure and exhaust into their respective condensers. While this requires a complicated system of steam piping, at the same time it creates a most convenient method of control both for sea-going and maneuvering.

Electrical Machinery and Appliances

For Generating, Transmitting and Using Current

Phase Advancers

BRIEF HISTORY OF DEVELOPMENTS; CONSTRUCTION OF PHASE ADVANCER; CONNECTIONS EMPLOYED IN ITS APPLICATION; BENEFITS TO BE DERIVED BY ITS USE; CURVES SHOWING EFFECTS OF THESE DEVICES

GREAT growth in the use of the induction motor in recent years has resulted in a real need for improvement in the power factor of supply systems. The importance of a good power factor is generally recognized to keep down line losses, increase the useful output of generators and reduce their cost. As early as 1891, the idea of using paper condensers for providing idle leading current to compensate the idle lagging current due to self induction in alternating-current systems, was proposed. As no real progress was made along these lines toward practical applications, and conditions then changed, the subject was dropped. Today, the most commonly used method for the correction of power factor of a system is the employment of over-excited synchronous motors, converters or synchronous condensers. Now, there has been placed on the market

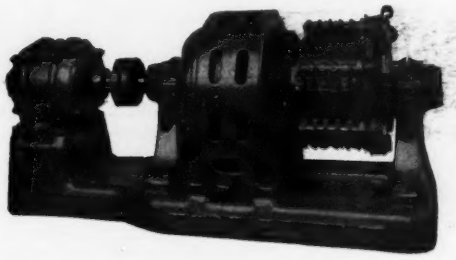


FIG. 1. ROTARY PHASE ADVANCER

a new type of machine, called the phase advancer, which is applied to the individual induction motor and has many advantages over other power factor correction methods.

In the synchronous motor, the magnetizing field is produced by a rotating magnet excited by continuous current. By supplying more continuous ampere-turns than are necessary to produce the normal magnetic field in any particular machine, it is possible to create in the system a leading current, which will compensate for a lagging current in another part of the system and produce unity or even a leading power factor.

The phase advancer stands in the same relation to an induction motor as an exciter does to a synchronous motor. For the induction motor, however, continuous current cannot be used for the magnetizing currents in the secondary because the motor slips under load. The magnetizing current must be polyphase of low frequency which corresponds in each instance to the slip of the induction motor.

CONSTRUCTION OF ADVANCER

THE PHASE advancer consists of a continuous current drum armature with a commutator having 3 brush studs per pair of poles, displaced relative to one an-

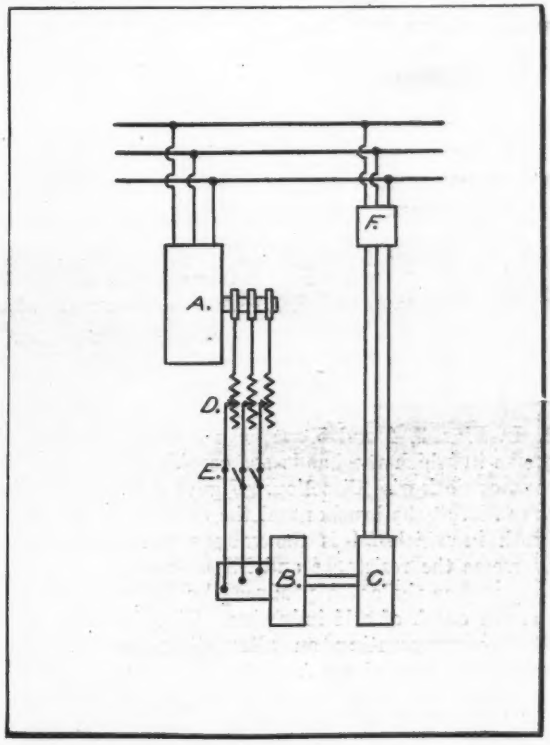


FIG. 2. DIAGRAM OF CONNECTIONS FOR APPLYING A ROTARY PHASE ADVANCER TO AN INDUCTION MOTOR

other by 120 electrical degrees. The stator consists of a frame with the laminations assembled, but having no poles or windings, as shown in Fig. 1.

The phase advancer is direct connected to a small squirrel-cage, constant-speed, induction motor. The only driving power is that required to supply the friction, windage and hysteresis losses and is, therefore, comparatively small, i.e., about 1 hp. for a 600-hp., 2000-

volt induction motor. The copper losses are provided by the main induction motor rotor.

In Fig. 2 is illustrated a simple scheme of connections where A is the induction motor; B, the phase advancer, direct connected to its driving motor, C; D, a standard controller and resistance for starting; E, a 2-pole, single-throw, short-circuiting switch; and F, a transformer and fuses. The switch, E, is used to short-circuit the phase advancer when starting the induction motor, A, which is accomplished in the usual way by the drum controller. Motor C is started, and after the motor A is up to speed, the switch, E, is opened.

Consider, for the moment, that the phase advancer is standing still and is receiving current at slip frequency from the slip rings of the induction motor. The phase advancer under these conditions acts as a 3-phase choke coil, the current producing a field which revolves in space at a speed corresponding to the frequency of the current supplied to the brushes.

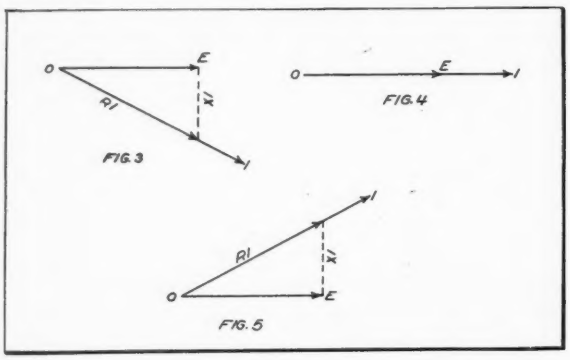


FIG. 3. VECTOR DIAGRAM, SHOWING CURRENT LAGGING BEHIND LINE VOLTAGE

FIG. 4. VECTOR DIAGRAM, SHOWING CURRENT IN PHASE WITH LINE VOLTAGE

FIG. 5. VECTOR DIAGRAM, SHOWING CURRENT LEADING LINE VOLTAGE

In Figs. 3, 4 and 5, we have 3 vector or clock diagrams in which the hands are considered rotating in a counter-clock-wise direction. Figure 3 shows the phase e.m.f., E, at the brushes and the current, I, fed to each brush in which RI is the voltage component used to overcome the resistance and XI is the component used to overcome the e.m.f. produced by the revolving field; i.e., the e.m.f. of self induction. This figure is typical of any representing an alternating current lagging behind the applied e.m.f.

When the armature is driven in the direction in which the field revolves and at a speed corresponding with the speed of the field, the relative motion of the field and the armature becomes zero; this is equivalent to the disappearance of the self-inductive effect, as indicated in Fig. 4, and results in the current being in phase with the e.m.f., or OE coincides with OI.

If, however, the armature is driven at a speed greater than the speed of the field, the XI component of Fig. 3 is reversed in sign and E assumes a position, as shown in Fig. 5; that is, the current will lead the e.m.f. This negative reactance e.m.f. in series with the rotor circuit of an induction motor is able to neutralize the reactance of the induction motor, which formerly pushed the primary current into a lagging phase. It is in this way that the condenser effect is produced and the power factor improved.

Benefits to Be Derived by Its Use

The phase advancer can be applied to any induction motor having a wound rotor and slip rings and can be designed to correct the power factor to unity from about ¼ to 1½ normal load. A new motor designed to work with an advancer can be made considerably smaller than one not using the advancer, due to the fact that it is cheaper to use a slightly greater amount of iron and considerably less copper in the construction of the motor. This, however, will naturally result in a cheaper machine and a worse power factor. This defect is, then, readily corrected by the phase advancer. The saving in the cost of the motor will compensate for the cost of the advancer. If a high power factor is desired, it is cheaper to build an iron machine with a phase advancer than a copper machine without any.

A smaller motor has smaller losses, so that the power to drive the smaller motor and phase advancer would

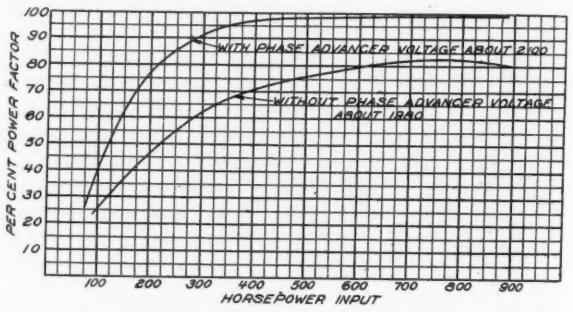


FIG. 6. THE LOWER CURVE SHOWS THE POWER FACTOR OF A 600-HP. INDUCTION MOTOR WHEN RUN WITHOUT A PHASE ADVANCER. THE UPPER CURVE SHOWS THE POWER FACTOR OF THE SAME MOTOR WITH THE PHASE ADVANCER IN CIRCUIT

in most cases be less than that required to drive a large motor without the phase advancer. By the application of a suitable phase advancer, the output of an old motor may be increased from 20 to 30 per cent and its power factor improved at the same time.

If the induction motor is not to be run continuously and in one direction the greater part of the time, the phase advancer cannot be used. Its most important application is to large, slow-speed motors which have an inherently poor power factor and to motors which run most of the time at part load and therefore at poor power factor.

Figure 6 shows a curve illustrating the effects of a phase advancer on a 600-hp. induction motor. The upper curve shows the power factor of the motor when run with a phase advancer and the lower curve, the power factor when run without the advancer.

Speaking of the growth of central stations, at Clayton, Wis., with a population of 220, a 12-hp. gas engine, belted to a 5-kw. dynamo, constitutes the municipal central station and furnishes current for street and commercial lighting. Not much chance for destructive competition or rate discrimination in that situation.

Practical Electrical Engineering*

SWITCHBOARD DETAILS—SWITCHES. BY NORMAN G. MEADE

VARIOUS knife switches for generators and feeders need no special mention, for they have no features of unusual importance as ordinarily used. They are made in various styles, such as 1, 2, 3 and 4-pole, double and single throw. Their use will be taken up with the description of switchboard connections.

There are, however, several types of switches of special construction: The field switch, the ground detector switch and the voltmeter switch.

It has been pointed out in the articles covering self-induction, that when the circuit is suddenly broken, through one or more coils of wire, the counter electromotive force rises to a large value and causes what is known as "inductive kick," which is liable to puncture the insulation of the coil winding.

It is important that some means be provided for quickly bringing the electromotive of a generator to zero in case of accident or damage to the machine, and this can be done only by opening the shunt field circuit, which is accomplished by a field switch, 2 types being shown in Figs. 7 and 8. The switch is connected in

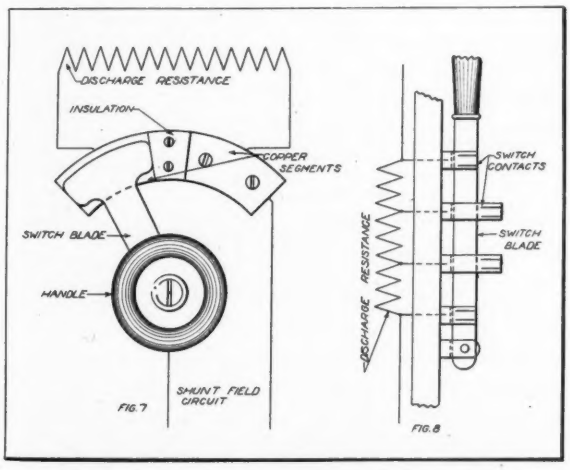


FIG. 7. FIELD CIRCUIT DISCHARGE RESISTANCE
FIG. 8. FIELD CIRCUIT DISCHARGE RESISTANCE

series with the shunt field circuit, and is provided with a discharge resistance of high value, so that when the handle in Fig. 7 is thrown to the left, as shown, the field circuit is not actually broken, but a resistance of such magnitude is introduced that the field current is reduced to a minimum, at the same time eliminating the "inductive kick."

The switch shown in Fig. 8 embodies the same principle, but the resistance is cut in by steps. It will be seen that when the blade is opened, the break is made successively from the top to the bottom contact.

For the sake of economy, where several generators are operated, it is customary to use but one voltmeter and provide some means of connecting it successively to the various machines. This is accomplished by a voltmeter switch; a common type is shown at A in Fig. 9. This particular switch is constructed for 2 generators and has 4 spring jacks, into which can be inserted the handle with 4 plugs shown at B; the connection scheme is shown at C. Each pair of plugs, one upper and one lower, is electrically connected, as shown by the dotted line at B, and when inserted in the jacks for generator No. 1, will connect that machine to the voltmeter. Similarly, generator No. 2 can be connected to the voltmeter.

For determining when a ground on the line exists, the device known as a ground detector, shown in Fig. 10, is used. For a 2-wire system, it consists of a simple 2-point switch, each point being connected to one side of the line; the handle is connected through an incandescent lamp to the ground. If, for example, there is

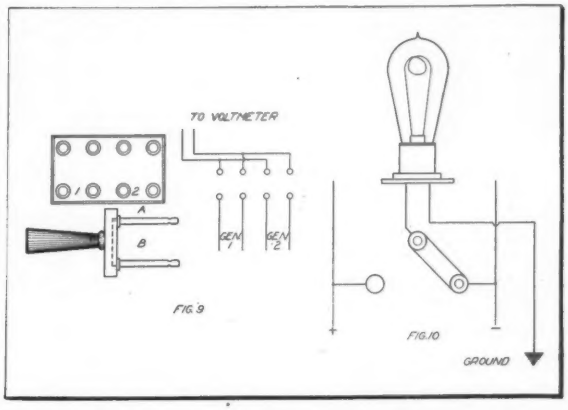


FIG. 9. DIAGRAM OF VOLTMETER CONNECTIONS; PLUG AND RECEPTACLE
FIG. 10. GROUNDED DETECTOR

a ground on the positive side of the circuit, when the switch is in the position shown, the lamp will light; the reverse is true of the negative side of the line. For 3-wire circuits a 3-point switch is used.

INDICATING AND RECORDING INSTRUMENTS

VOLTMETERS and ammeters are made in several different designs; but a type widely used is shown in Fig. 11, the lower part of the figure being a horizontal cross-sectional view of the lower end. The permanent magnet sets up lines of force across the air gaps and through the soft iron center core. Swinging on pivots is a rectangular coil of fine wire which is free to make a partial revolution in the air gap. The coil carries the pointer and is held normally at zero by 2 small coiled springs. When current passes through the coil, reaction between the magnetomotive force of the coil and the magnetic field set up by the permanent magnet takes place and the coil swings on its pivots.

To avoid the necessity of passing the full line current through an ammeter, a device known as a shunt, shown in Fig. 12, is used. It is connected in series with one of the generator leads and consists of copper ter-

*Continued from page 636, June 15 issue.

minals to which are soldered several strips of alloy with slightly higher resistance than copper. The ammeter leads are connected to each end of the shunt and the drop in potential through the latter causes a current of small value to flow through the ammeter, the current being proportional and in direct ratio to the full load current flowing through the main conductor. The ammeter is so calibrated that the actual circuit current is indicated.

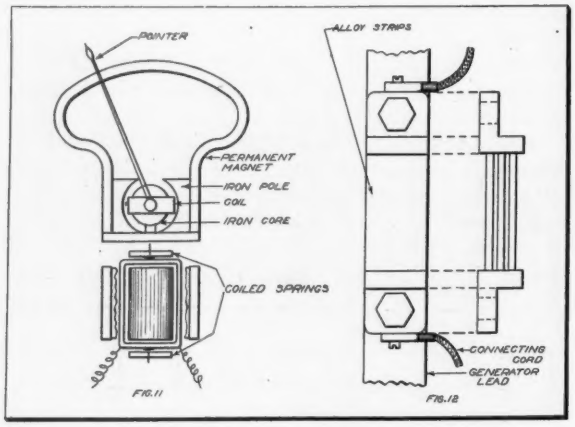


FIG. 11. SKELETON DIAGRAM OF VOLTMETER
FIG. 12. AMMETER SHUNT

For totalizing panels, and many times for feeder panels, where it is desired to keep account of current used on various circuits, it is customary to install integrating wattmeters. The principal details of such an instrument are shown in Fig. 13. It consists essentially of a miniature electric motor which actuates dials similar to those of a gas meter. Attached to the armature spindle is a copper disk which revolves between the lips

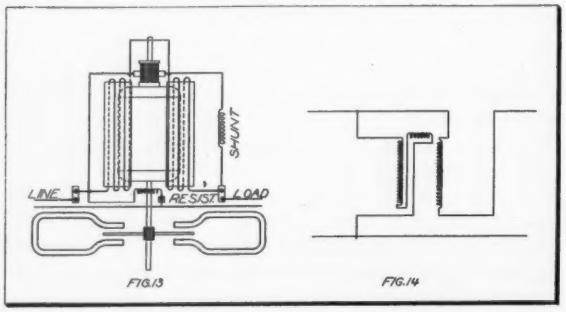


FIG. 13. DIAGRAM OF INTEGRATING WATTMETER
FIG. 14. CONNECTIONS OF INDICATING WATTMETER

of several permanent magnets, this latter combination acting as a damper, limiting the speed for the various loads. The magnetic field set up by the permanent magnets induces a current in the copper disk which reacts on the field, causing a retarding effect. The speed of the meter is at all times directly proportional to the load carried. The connections shown are for a 2-wire meter; 3-wire meter connections vary somewhat, but the principle is the same.

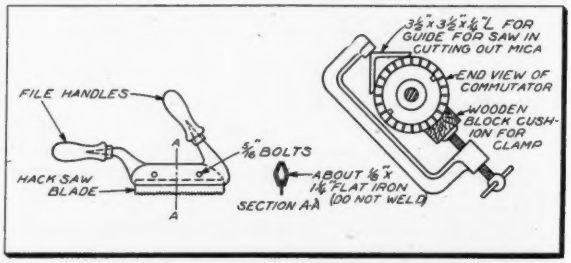
Indicating wattmeters involve similar principles; but instead of a revolving element, an element that rotates through part of a revolution only is substituted and is similar in action to a voltmeter or an ammeter. The connections of an indicating wattmeter are shown in Fig. 14.

Recording instruments that give a continuous ink record on a paper dial or a paper ribbon are now quite extensively used, especially voltmeters, amperemeters and wattmeters. By their use, a continuous record of voltage, current and watts can be kept. These instruments have mechanisms similar to an indicating instrument, with the exception that a pen, which is in contact with the paper, is substituted for the pointer. The paper dial or the ribbon, whichever is used, is moved by clockwork, the divisions or graduations representing minutes and hours.

Undercutting the Mica in Commutators

By F. W. Salmon

I HAVE read with much interest the articles on this subject in Practical Engineer. From reading some of them an inexperienced person might suppose that dynamo and motor troubles would be about all over when the mica was undercut, but this is not my experience; in fact, the undercutting sometimes leads to greater troubles, if the mica is thick or the undercutting is too wide, or the carbon from the brushes gets packed in the grooves or copper leaf or copper wire gauze brushes are used, the commutator bars may short-circuit on the edges enough to make them very rough or even worse and give the attendant a busy time; for these reasons, it should be done carefully and neatly, if trouble with the commutator makes it appear desirable to try this remedy.


3½" x 3½" x ¼" "L" FOR GUIDE FOR SAW IN CUTTING OUT MICA
END VIEW OF COMMUTATOR
WOODEN BLOCK CUSHION FOR CLAMP
FILE HANDLES
5/16" BOLTS
HACK SAW BLADE
ABOUT ⅛" x 1¼" FLAT IRON (DO NOT WELD)
SECTION A-A

UNDERCUTTING DEVICE AND GUIDE

From my own experience I could not recommend cutting the grooves ⅛ in. wide, but only just removing the hard and troublesome mica; and to use a hammer and chisel on a commutator, even if the commutator is new and very stiff and secure, does not appear to me to be as safe or quick as the method I have commonly used and shall describe below.

Take a thin hacksaw, so that the width cut by the hacksaw will just remove the mica, and break the blade into short pieces from perhaps an inch long for the commutators of very small motors, up to 3 or 4 in. long for large commutators, and fasten them in the hand-clamp shown, which, for a commutator about 8 in. in diameter, may be made of flat iron about ⅛ in. thick

by 1¼ in. wide with 2 5/16-in. bolts, as shown; I commonly use 5/16 by 1-in. countersunk head stove bolts, putting a washer under the nut made by cutting 2 pieces of ⅛-in. iron pipe each ½ in. long.

For a guide for the saw, I clamp on the commutator a short piece of light angle iron; for an 8-in. diameter commutator, a few inches of a 3½ by 3½ by ¼-in. angle serves well, as shown in the sketch.

With this simple device, made on the ground when and where required, a man can use both hands to advantage and get the mica out to a depth of a few hundredths of an inch quickly without any danger of injury to the commutator if just a little care is used.

I consider that it is preferable to place the piece of hack saw blade in the holder so that the cutting is done on the pulling stroke. Almost any bright, willing young man around the plant can be taught to do this work well in a few minutes with these tools, thus leaving the engineer, electrician or other high-grade mechanic free to use his time, skill and experience on more important matters.

Short-Circuit Test of Large Generator

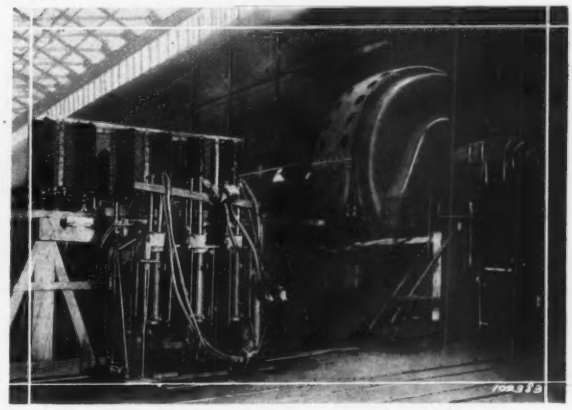
IN the presence of a number of representatives of central stations, the engineers of the Westinghouse Electric & Mfg. Co. deliberately short-circuited a 16,700-kva., 8800-volt generator, running at full speed and without resistance or any other protection in the circuit. Oscillogram records showed that a current of 21,000 amp., or 12½ times normal, flowed through the generator.

With generators designed some years ago, such a test would have wrecked the machine; but in the present instance no damage whatsoever was done. The only visible effect was a static flash between the field and the armature.

The test was performed to prove the fact that generators are being built that require no outside protection from outside short circuits, the generator itself being so designed as to be self-protecting. Unless the generator is properly constructed a complete short circuit tears out the armature coils, which, coming into contact with the revolving field, causes extensive wreckage. Furthermore, the static flash, which always occurs under such circumstances, will destroy inferior insulation. With generators of the type tested, however, both results are guarded against by firmly securing the armature coils and bracing their ends, on one hand, and by the use of mica insulation on the other. In consequence, even so severe an ordeal as this test was withstood without harm, although it has been repeated many times with the same machine.

In connection with this test several others were carried out in order to prove the reliability of circuit-breakers and reactance coils for protecting the feeder circuits. The generator was repeatedly short-circuited through these devices which stood up admirably under the enormous stresses to which they were subjected.

The practice recommended by the Westinghouse engineers is to protect the feeders and not the generators. If the generators are protected and a short-circuit occurs on any of the feeders, even a poorly designed generator will not suffer; but the voltage will fail on all the feeders, all synchronous motors will be thrown out of step, and an overwhelming overload will be thrown on the circuit-breaker of the short-circuited feeder, since it will carry the total current of all the generators in the station. If, however, protective reactances are placed in each feeder circuit, and a short circuit in a feeder occurs, only that feeder will be affected, and even then its reactance coil will prevent



LARGE GENERATOR BEING TESTED BY SHORT-CIRCUITING

the current in it from rising to too high a value. The voltage will be maintained at the bus bars and no disturbances will be felt in the remaining feeders. This happens, of course, provided that the generators are self-protective; if not, such an event may seriously injure them.

It is, of course, possible to protect non-self-protecting generators by reactances; but, as the test described above shows, such a proceeding is unnecessary with generators that are immune to the worst conditions of load that can be imposed upon them.

THREE HUNDRED MILES an hour is certainly some rapid traveling. A trip from New York to Chicago in 3 hr., and from Chicago to San Francisco in 10 hr. is nearly annihilating space. No it isn't flying machines; it's a report of experiments on a new railroad system made in London recently. The train travels through space supported by the repulsion of a magnetic coil on "certain metals," one of which is stated to be aluminum. No details are given, but it is fair to assume that the experiments were made on small models and over short distances. And one wonders what power was required to overcome gravity and the air resistance at this terrific speed. Also, with no guiding rails, what method of control is used, and what would happen if the train at that speed jumped the repulsion track and came down to earth?

APROPOS OF the safety first and efficiency movements, a correspondent, who signs himself Rekcutaw, suggests that Proficiency also deserves special attention, and proposes a 3-fold slogan for Power Plant Progress:

1. Safety Secures Surety.
2. Efficiency Enlarges Effect.
3. Proficiency Produces Performance.

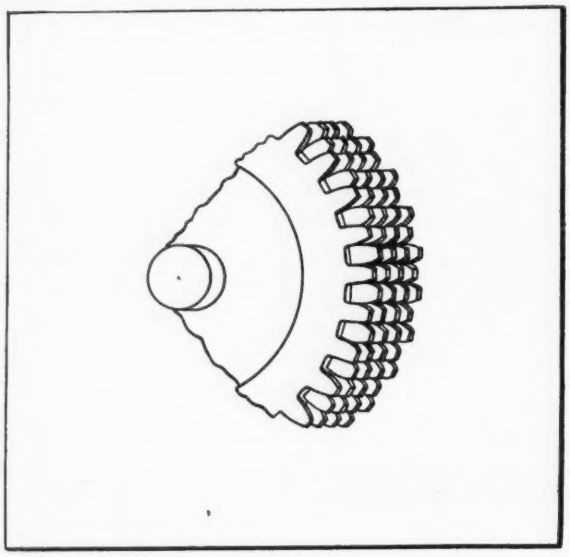
Foreign Development in the Power Plant Field

SOME NEW INSULATING COMPOUNDS. BY J. H. BLAKEY

IN the Revue generale de Chimie, M. Main gives some receipts for making electrical insulating compounds. He divides these into the following classes: 1. Those having a base of resin, wax, oil or paraffin. 2. Mixtures of asphalt, tar or pitch. 3. Mixtures containing gelatine, casein or albuminoid materials. 4. Cellulose insulators. 5. Mixtures containing some of the foregoing materials as well as others.

The following compound, belonging to the first class, is suitable for all purposes where elasticity is not indispensable: White resin, 32 parts; oxide of zinc, 20 parts; powdered marble, 48 parts. The oxide of zinc is added to the melted resin; stir and add the marble. When thoroughly mixed, pour into a mold.

To protect the winding of transformers, the following mixture, which is not affected by oil, is used: 91 lb. of Kauri gum, 42 lb. resin, melt and add 6 gal. of castor oil.



SECTION OF SHEET STEEL GEAR WHEEL

The product which goes by the name of "Dielectrine" may be prepared by either of the following processes: Sulphur is melted and sufficient paraffin is added to cover the mass, which is heated to 130 deg. C., stirring with a glass rod. The brown product is much less fragile than sulphur, notwithstanding its high proportion of this element. Or, paraffin is heated to 105 deg. C., and maintained at this temperature for some time by means of a water-bath of salted water, then powdered sulphur is poured in until a thick paste is obtained.

The following insulator is plastic, impermeable to water, and may be buried or immersed without injury. Take equal parts by weight of pulverized mica, powdered resin and resin oil. Heat together until thickening is followed by refluidification. The hardness or suppleness can be varied by adding more mica or oil.

Insulator for conducting wires: Linseed oil is heated to 300 deg. C., and mixed with 2 per cent of oxide of zinc, and 2 per cent oxide of lead. When the mixture becomes thick, add 25 per cent of resin oil and allow it to cool.

Another insulator for wires and cables: Pure, fine sand, 66 lb.; mineral oil, 34 lb.; wax or paraffin, 25 lb.; boiled linseed oil, 3 lb. Heat and mix. For wires, increase the proportion of paraffin, and diminish it for cables.

2. Insulators having a base of tar or pitch.

For insulating wires, use a coating of stearin pitch; this is known under the names of candle pitch, chandler's gum or residuary gum, and is used in the manufacture of roofing cements. It is heated to 200-350 deg. C.; after cooling, it is as hard as gum lac. This stearin pitch is soluble in alcohol, benzine or tetrachlorid of carbon, forming an insulating varnish which can be hardened after application by heating to 250-300 deg. C.

An impermeable, incombustible and economical insulator is made by mixing plaster with 1/10 of its weight of asbestos; after pouring into a mold and drying, it is dipped into a bath of pitch, to which a little sulphur has been added.

3. Insulators having an organic base.

The whites of 6 or 8 eggs are mixed with 100 lb. of commercial casein, and dissolved in an alkaline lye; after filtration, sufficient oxide of zinc is added to form a hard paste.

An insulator is prepared with scraps of leather, hair, feathers, horn, etc., by cooking for a considerable time in paraffin heated to 100 deg. C.; it is then pressed to get rid of the surplus paraffin, and allowed to cool.

4. Cellulose insulators. Thin insulating for wires:

Tetrachlorid of ethane	93.5 parts
Acetylcellulose	6.0 parts
Pyridine	0.5 parts

To replace the gum lac in armature windings:

Tetrachlorid of carbon	87 parts
Acetylcellulose	12 parts
Pyridine	1 part

5. An acid resisting insulator is made as follows:

Asphalt	40 parts
Carnauba wax	16 parts
Refined suet	24 parts
Codfish oil	1 part
Paraffin	2 parts
Calcined asbestos	6 parts
Boiler linseed oil	18 parts
Flowers of sulphur	7 parts

The asphalt, wax and paraffin are melted and mixed. The oils and the sulphur are kept at 200 deg. C., until they assume a syrupy consistence. The first is then added to the second, and the remainder stirred in. After thorough mixture it is allowed to cool. This composition is used in place of ebonite.

Gear Wheels of Sheet Steel

The French house of Herbert Ferry has just put on the market a gear wheel made of sheet steel. Each plate is of such thickness as can be cut with a die, the key-way being cut by the same means. By this method there is obtained an excellent compensation for any irregularities of cutting, a perfect tempering in consequence of the thinness of the plate, and a great reduction in cost of manufacture.

An interesting variation of the process is shown in the figure, in which the plates are so arranged that the position of the teeth is alternated. This is said to give a perfectly smooth and almost noiseless action.—From La Nature.

Correspondence of An Old Engineer and His Son

Donald Summarizes His 5 yr. Experiences Upon Reaching a Long Coveted Goal

My dear father:—

I have at hand your interesting as well as welcome letter of a few days ago, and as I have a little time this evening, I will reply, for there are many things that you will be interested in that have happened around here lately.

I wish to take this opportunity to present you and mother with a new daughter and her name is Hazel. I suppose that you have suspected it for some time, not that the "deal had been consummated," as they say, but rather that it would be in the not distant future.

It is now something over 5 yr. since I came to Daneberg and began on the steering gear of a wheelbarrow at the plant of the Daneberg Manufacturing Co. Many things have happened since then. There have been many perplexing problems at the plant and they have taxed my ingenuity in spite of the fact that you paid out perfectly good money for my education at the Bergville Technical Institute.

As I look back, I cannot recall a single thing that was done the way we were instructed to do it at "Tech." I remember that "Prof." used to elucidate by the hour on the why's and wherefore's of the injector and the technicalities attending its refusal to work; but I found that when we had to use the injector in doing a little packing on the feed pump, or putting in a new set of valves, most of these so-called technicalities consisted of a piece of a hard rubber valve disc that had wiggled its way down into the combining tube and no amount of theorizing would restore things to their normal conditions; a monkey wrench was the only remedy.

The Chief, now my father-in-law, is pretty well along in years, and he has been threatening for some time to retire; but I suppose that he is like all real mechanics (or any other real artisan, for that matter), he hates to set the date when he will shut off the oil, blow the whistle, and close the throttle for the last time, and step out and give way to another man.

But in the present instance, he has sort of "raised" his successor right on the job. The day before the wedding, he went up to the office and was there for a long time. When he returned, he brought the president of the firm with him, and they talked at length over by the switchboard. Soon the president came over to me and, although he wanted to say something, he seemed at a loss as to how to start. But finally he blurted out the cold facts that the old Chief wanted to carry out a long cherished wish and retire, and that they wanted me to take his place, saying that it was a sort of combined reward for services, and a wedding present.

Father, for the first time since I came here, I was at a loss as to what to say or to do. Of course, I was all broke up about the Chief leaving, but even if I was selected to take his place, I could not regain my former poise.

Now that the ice was broken, no one seemed at all anxious to jump in, so to speak. The Chief fussed a little with a lubricator that was all right, and the president looked around at the vast array of machinery that was so foreign to his line of thought, and finally after blowing his nose several times lustily, went out.

The Chief sat down at the desk, raised his feet on the top drawer, and sat gazing out of the window. He thought I didn't see him, but several times he wiped his eyes with the ever present red bandana.

And me? Well, father, there was a lump in my throat that would not be swallowed. I felt like beating an old man out of a job; but as it all seemed to be cut and dried at one place or the other, I finally "came to."

Of course, such a thing as a trip in connection with the wedding was out of the question at this time, owing to certain little changes that are being made and which must be worked out as we go along, more or less. But I hope that all will be arranged so that I can have 2 weeks off next September, and WE will go to the Big Convention at Milwaukee, and also spend another week with you and mother.

The Chief has been industrious all his life and has made good money; he presented Hazel with a little 6-room cottage, with $1000 paid down on it. Well, that looks pretty good and I think it will not take long to clear the rest of it.

The boys that I have become acquainted with at the works were profuse in their congratulations, as to both the girl and the job. Fred, who didn't find out what he was good for till he got fired, and re-hired, is now my assistant. Crissy Montgomery, who was a classmate at "Tech.," is now at the head of the sales department, and stands a good show of going higher. We often laugh at the clever way that the oil agent was caught and the part we both played in the game.

Well, father, there have been a great many changes made here since I first came on the scene. There is hardly a piece of machinery in the plant that has not been moved or changed some way or other. All of the old return-tubular boilers have been torn out and new water tubes put in their place. The old screwed pipe header that was several sizes too small for the work has been replaced with a high-pressure welded flange and

nozzle header, and all ugly square corners have given way to loops of generous radius.

New engines have been installed and new generators, and the switchboard completely remodeled. Almost all of this work has been done under my supervision, as the Chief had so many duties to look after that he turned the engine room over to me to change and still keep running.

Now, father, I want to say right here that I can realize more than ever that your advice at the time I left "Tech." was the best that I ever received. It was "hard lines," but I knew that you would not advise me wrongly, so I wheeled ashes and studied, to the best of my ability, and I can see now that it has brought results.

I can see so many young men here in this town that are making the fatal mistake of not wanting to stick to anything very long. There are 3 or 4, particularly, who change jobs every time the boss disagrees with them. The instant that they are corrected, or "called" for anything, they tell him to "go and jump in the lake," or something like that, and are off to another job.

While I admit that one should have some variety to his experience, generally speaking, yet I cannot see that one has to change every month or so. It takes him as long as that to find out where the time clock is, where all the stock is kept and the other little things that are learned only by contact.

Well, your new daughter is inquiring if I can put up a picture molding, and assuming that she is from Missouri, I must close and show her that it can be done. I suppose that she will also want a bag of flour emptied, and a shelf put up in the entry to put the dishpan on, and a nail driven in the wall to hang the frying pan on, as well.

Married life is a great business. Together, we bought everything that we thought we would need, but it seems that we have left out the most important things. First it is a flour sieve, then a wood spoon, and a graduated quart measure, and a can opener and 1001 other things. But no use telling you, father. You found those things out 50 yr. ago, when you were a young engineer. Possibly a recital of these petty incidents recalls some memories you might wish to forget.

So, sending love to both you and mother, from Hazel as well as myself, I will close,

Affectionately, your son,

DONNY MACDOUGAL.

P. S.—When are you going to write me all about your engineering experiences back in Philadelphia in the 1850's?

The Use of Tar Oil As A Fuel

KINDS OF FUEL; OPERATION OF DIESEL ENGINES; TYPICAL PLANTS

ATTENTION which has recently been paid to the development of the internal combustion engine, has brought into prominence the feasibility of using fuels which, until its advent, occupied a position of secondary importance. With the increasing use of power and the advancing price of fuel, it becomes more and more necessary to turn one's attention to the most economical source of power; for this reason, the Diesel engine with its low running costs, its great degree of utilization of heat value of fuel, and its possibility of utilizing the cheapest grades of liquid fuel, forms an interesting solution to a difficulty which is likely to become greater as time goes on.

Although much has been said concerning the limitation in the supply of crude oil for fuel purposes, it would appear that the large and ever increasing production of crude oil, and the opening up of new oil fields will always provide sufficient fuel oil for internal combustion engine work. The numerous oil fields and the possibility of using the most varying grades of fuels in the Diesel engine are the safeguards against the formation of trusts in the fuel oil market the world over, and consequently any permanent advance in the price is rendered improbable. At the present time, duties are levied on the importation of fuel oil in some countries; but this practice is by no means universal, and with the exception of Germany, France and Spain, there are few countries where heavy duties are levied on crude oil, even where it is used exclusively for heating and power purposes. At the same time, the price of fuel oil is sufficiently high to make it interesting to cast around for other suitable materials.

The 3 main sources of the principal liquid fuels are crude oil, lignite tar and coal tar. The first gives as its main distillate petrol, lighting petroleum and fuel oil of a specific gravity of 0.83 to 0.05, and a heating value of about 18,000 B.t.u. per lb. Lignite tar, on distillation, gives a lighting oil, and a paraffin or fuel oil of specific gravity of 0.88 to 0.90, and a heating value of about 17,600 B.t.u. per lb., while coal tar on distillation provides us with benzol and medium density oils, and also heavy oils, such as creosote oil and anthracene oil. Taking these 2 latter fuel oils, the specific gravity on an average may be taken as 1 to 1.1, and they have an average heating value of about 15,800 B.t.u. per lb.

In England, where coke production and coal gas making is so extensively adopted, the use of fuel oils produced from coal tar, presents a most interesting problem and there appears to be no doubt that in the comparatively near future, we shall see, on the one hand, electrical generating stations operated by Diesel engines placed at or near to coke oven plants, and on the other hand, a much closer connection between the electrical and gas making industries. Heavy coal tar oil, moreover, is free from duty in all but a very few countries, and is obtainable all over the world in large quantities. In this direction, Messrs. Maschinenfabrik-Augsburg-Nurnberg A. G., who have done a great deal to popularize the Diesel engine, have been able to show excellent results and by means of patented devices have solved the question of the use of heavy tar oil. Coal tar oil can be imported into France, for instance, free from duty, a fact which determines the price of the tar oil produced locally. Germany, in particular, ex-

ports tar oil to France, for it produces large quantities of suitable tar oil, the price of which at present time stands at 42 shillings per ton, free on rail at the Franco-German frontier. As coal tar oil has a heat value about 12 per cent lower than crude petroleum, the consumption is correspondingly greater.

The M. A. N. Diesel Engine

The Maschinenfabrik-Augsburg-Nurnberg A. G. Diesel engines are built either as 4-cycle or as 2-cycle engines. In the former case, in a single-acting engine, pure air is drawn into the cylinder on the first stroke, compressed to from 450 to 480 lb. per sq. in., and highly heated on the second stroke. On the third stroke, the fuel is injected by compressed air and then ignited by the hot air, thus securing perfect combustion in a gradual manner, followed by expansion of the gases driving the piston forward on the working stroke. On the fourth stroke, the waste gases are exhausted to the atmosphere.

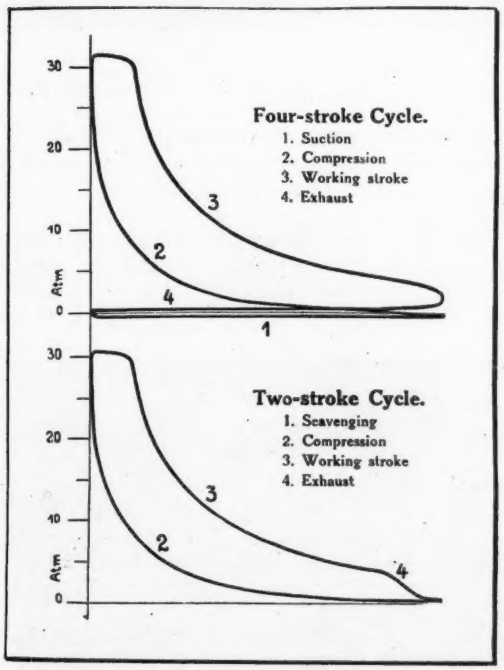


FIG. 1. SHOWING COMPARISON BETWEEN 4-STROKE AND 2-STROKE CYCLE

In the 2-cycle, single-acting engine on the commencement of the first stroke, a special charging pump fills the cylinder with a slightly compressed air at the same time scavenging out the products of combustion. The air is then compressed as in the compression stroke of a 4-cycle engine. On the second stroke, fuel is injected by compressed air and work is done as in a 4-cycle engine. When the piston has traveled about 6/7 of its stroke, it allows the exhaust gases to escape through exhaust ports, the pressure dropping almost to atmospheric, whereupon a fresh cycle commences. Figure 1 shows a comparison between the 4-stroke and 2-stroke cycle, the operations being numbered in order. In the double-acting engines, the same procedure is followed at each end, the piston being acted upon from either side. One cylinder, therefore, develops twice the power of a cylinder of the same size in a single-acting engine.

The usual type of stationary M. A. N. Diesel engine works on the 4-stroke cycle; but for large units, 2-cycle engines are also built. The determining factors in each case have to be settled as to whether the 4-cycle or the 2-cycle engine will effect the greater all around economy, taking into consideration the price of fuel, load factor and first cost.

Figure 2 shows a section of an ordinary vertical, single-acting, M. A. N. Diesel engine. An interchangeable cylinder liner is fitted into a strong frame and bolted into a bedplate, the bottom of which forms the oil catcher. Air inlet and exhaust valves, together with

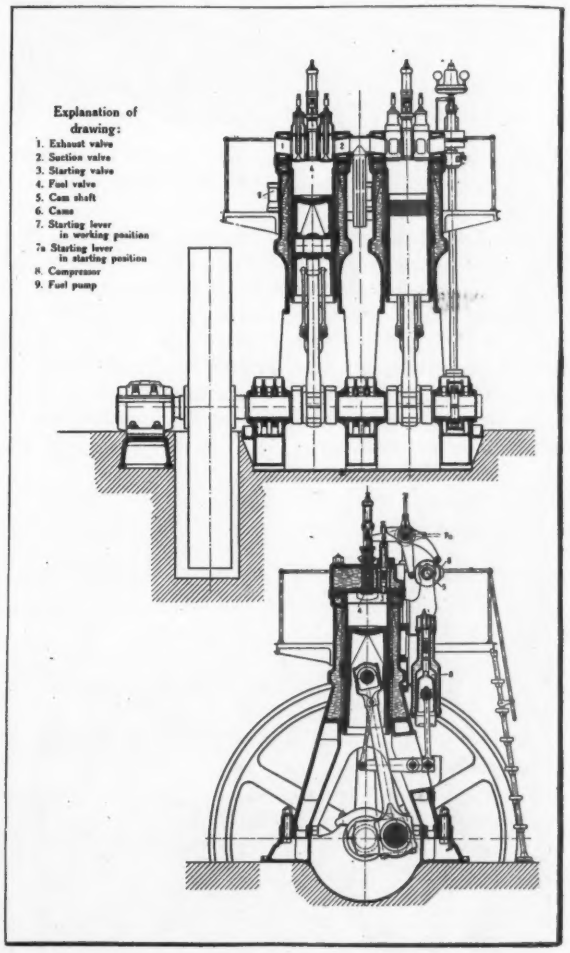


FIG. 2. SECTION OF VERTICAL, SINGLE-ACTING, M. A. N. DIESEL ENGINE

fuel admission and compressed air starting valves, are all arranged in the cylinder head. A long trunk piston of special design works in the open cylinder, this piston ensuring slight surface pressure and minimum wear and tear. The cylinder and its cover are water cooled, the water consumption at 50 deg. F., inlet, and 158 deg. F., outlet temperature being 2.2 gal. per b.hp.-hr. for medium and large sized engines, and 3.3 gal. for small engines. The 2-stage air compressor supplies compressed

air of from 725 to 870 lb. per sq. in. for filling the starting and injecting reservoirs. The latter contains the compressed air for injecting the liquid fuel supply by a small pump, the quantity delivered by this pump being controlled by the governor.

The double-acting, 4-cycle engine is built in tandem and twin tandem arrangement. In the former case, the 2 cylinders are arranged in tandem, working together

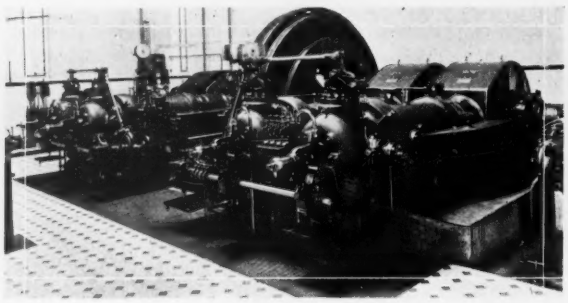


FIG. 3. THREE 400-HP. M. A. N. DIESEL ENGINES IN MUNICIPAL POWER STATION AT SCHANDAU IN SAXONY

in such a way that each stroke is a working one. For large units, at present up to 4000 b.hp., double-acting, M. A. N. Diesel engines are built in twin tandem arrangement. The cylinders are fitted with 2 fuel inlet valves at each cylinder end, this being a patent arrangement to secure rapid and perfect combustion. Cylinders, pistons, valve chambers, stuffing box shell, crosshead guide surface and crank shaft bearings are all thoroughly water-cooled.

2-cycle double engines have, like the horizontal 4-cycle engines, only one line shaft operating all valves of both cylinders. The scavenging valves of the 2-cycle engines occupy the same position as the inlet and outlet valves of the 4-cycle engine. All these valves are operated by rolling levers deriving their motion from the eccentric.

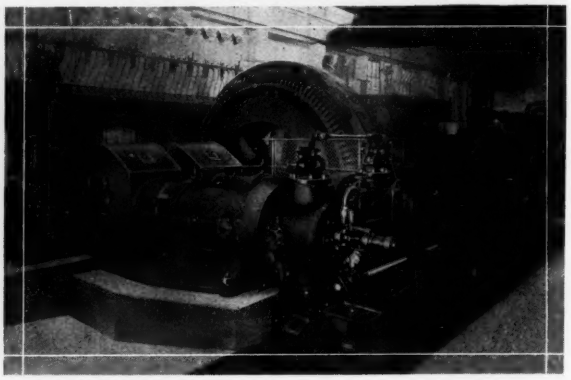


FIG. 4. TWO 400-HP. M. A. N. DIESEL ENGINES AT CORPORATION POWER STATION OF KINGSTON ON THAMES

The scavenging pump is arranged at the side of the bedplate and connected firmly to the compressor, so as to form one unit. It is fitted with a positively driven piston valve.

Figures 3, 4 and 5 show photographically some horizontal M. A. N. Diesel engines equipped for running on tar oil. Figure 3 is an installation of 3 horizontal, single-acting, 4-cycle, 4-cylinder engines of 400 b.hp.,

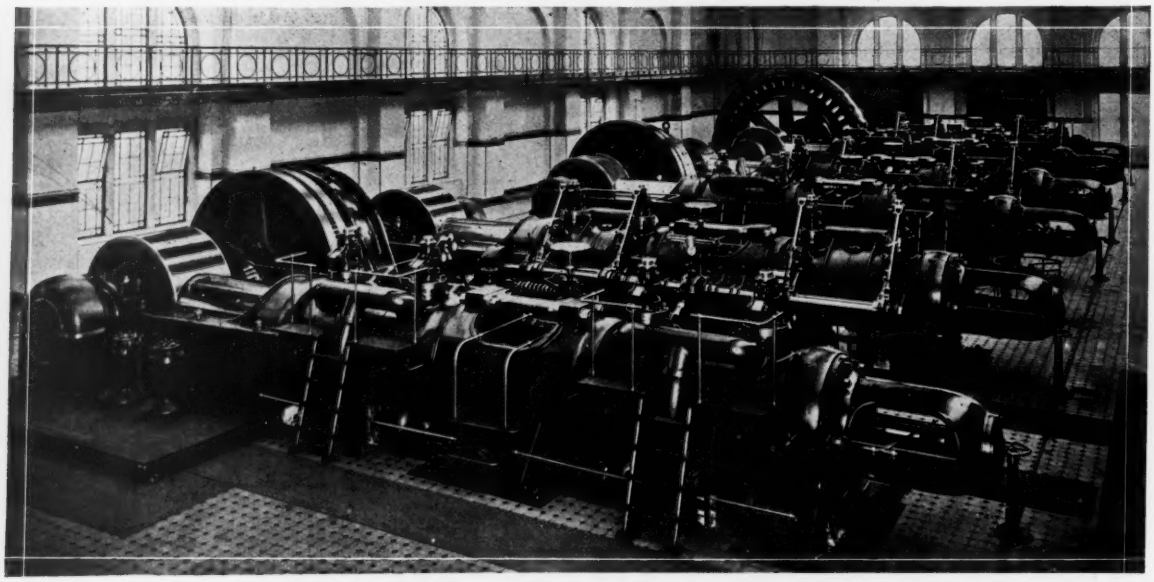


FIG. 5. THREE HORIZONTAL, DOUBLE-ACTING, DIESEL ENGINES OF 1600 HP. EACH, AT THE MUNICIPAL PLANT OF HALLE, GERMANY

Single-acting, 2-cycle engines are built only as double engines, that is to say, for 2 cylinders arranged side by side. The cylinder heads are similar to those of the horizontal 4-cycle engines resting with special supports on the foundations. The pistons are water cooled. The

each direct coupled to flywheel alternators and operated on tar oil as fuel. This installation is at the Municipal Power Station at Schandau in Saxony. Figure 4 shows 2 horizontal, single-acting engines of 400 b.hp. each, one of which is a 4-cycle, 4-cylinder engine, the other a 2-

cycle, 2-cylinder engine. Each of these is direct coupled to a single-phase alternator and is constructed to operate either on crude oil residue or tar oil. They are installed at the Corporation Power Station of Kingston-upon-Thames. The last illustration is of 3 horizontal, double-acting engines in twin tandem arrangement of 1600 b.hp. each, operating on tar oil at the Municipal Plant at Halle, in Germany. All these plants appear to be giving complete satisfaction and are a striking example of the way in which tar oil is being utilized as fuel for the production of electric power and lighting.

Points on Steam Boiler Construction*

By H. A. Baumhart

GREAT progress has been made in boiler design and construction during the last 20 yr., and few, if any, boiler manufacturers would now construct a boiler without taking into consideration safe rules as recommended by good engineering practice.

In good design the shell, including the covering strips of the longitudinal joint, must be formed to a true circle to avoid bending, and this would exclude lap seam construction, as is now done in Ohio and Massachusetts, except in shells of small diameter, and for comparatively low pressure, 36 in. or under and carrying under 100 lb.

For flat surfaces, solid stay bolts are commonly used with factor of safety of 7 or 8. This is necessary, as the bolts are subject to strains due to unequal expansion and contraction, causing bending. When fires are lighted, the inner box plate or tube sheet is heated first and expands before the outer plate; later, the outer plate expands up to or beyond the inner; thus making 2 bends of the bolts each time, slight to be sure, but sufficient to break the bolts, where fire boxes are of considerable length, sometimes within a month of going into service. As the outer plate is usually the thicker, the bending and breaks generally occur at this plate, or the movement of the bolt in the outer sheet may cause corrosion and flaking of the sheet at the inner end of the bolt hole. With lighter plates, the bolt may bend the plate until it causes cracks extending in every direction from the bolt hole on the inner surface of the sheet, where they are difficult to find and may not be discovered until leakage occurs. The hollow bolt, which will show leakage when it is broken, is preferred by some inspectors.

Heads for drums or domes should be convex or "bumped," carefully formed to true curvature of a segment of a sphere to avoid bending under pressure. Where a manhole is used, the head should be of material 1/8 in. heavier than for a blank head to give extra stiffness and avoid bending because of the opening.

Steel has replaced wrought iron in boiler construction, and care is necessary in preparation of steel for boiler plate. It must be made by the open-hearth process with phosphorus not over 0.03 per cent and sulphur not over 0.04 per cent for the best grade. To secure sufficient ductility, the maximum tensile strength required is 60,000 lb. per sq. in., but 54,000 lb. is preferable. In place of the present requirements of many rules for flange steel, 55,000 to 65,000 lb. tensile strength, it would be better to make the basis of calculation for strength of sheets 52,000, and allow a variation of 8000 lb., above this figure. This would call for a heavier boiler, but would insure better ductility of the material and do away with the temptation to cut test specimens from the high test end of the sheet in order to meet the figured strength. The extra insurance of safety would be worth the extra cost.

Cast iron should not be used for any pressure parts of a steam boiler, even for heating, if a pressure is to be carried of over 15 lb., as the thickness and quality of the casting are always matters of some uncertainty.

Forming of shell and butt straps should always be done by rolls or pressing to true shape, as fitting with a sledge hammer is likely to result in cracks so fine as to defy detection, but likely to extend and become dangerous after the boiler is put into service.

No rivet hole or tube hole should be punched. They should be drilled from the solid, as punching small and reaming may remove a considerable part of the disturbed molecules, but not all of them. Bevel shearing of edges that are to be calked produces a like result of numerous minute cracks, and such edges should be planed bevel, as will soon be required by Massachusetts and Ohio rules.

As to factor of safety, 5 should be the minimum. Tests in the transactions of the A. S. M. E. show that with a factor of safety of 2, 20,000 repetitions of stress produced rupture; with a factor of 2.5, 210,000; with factor 3, 700,000; and with factor 3.5, 1,600,000 repetitions. So that for a factor of 4 or less, a boiler might be expected to fail many years sooner than one with a factor of safety of 5 or over.

Because of this process of fatigue and deterioration under heat, which is hastened by the presence of phosphorus in the metal, experience shows that after 20-25 yr. of service a boiler should be taken out of service, even though inspection does not show how or when it is likely to fail. The factor of safety does run down, and continuing the boiler in use for high pressures becomes dangerous.

Deterioration of boilers may be hastened by overheating, a common cause of this being a deposit of scale, sediment, oil or grease, or a combination of these. The presence of oil or grease, even in moderate amounts, is dangerous, and it should be promptly removed and its recurrence prevented.

This and other conditions call for careful operation and frequent inspection and the adoption of every possible safeguard to prevent accident, including the entrusting of boilers only to those fitted to care for them.

*From a paper before the Ohio Society, Mechanical, Electrical and Steam Engineers.

According to the figuring of T. Alfred Fleming, of the Ohio State Fire Marshal's Office, the money spent each year in extinguishing fires in the United States is equal to the amount of money coined annually for the nation, plus the interest on the national debt, plus the amount required for the upkeep of the American Navy. And all this quite aside from the enormous loss caused by fires.

An Electric-Driven Plant for Ice Making

THE EQUIPMENT REQUIRED AND COST OF OPERATION FOR A 30-TON ICE PLANT USING RAW WATER

IN Centerville, Ia., is a small plant operated by the Pure Ice Co., of that city, and described by S. A. Martin before the Western Ice Manufacturing Association. The motive power for this plant is a 100-hp. slip-ring induction motor, running at 690 r.p.m., full load, and taking current at 2200 volts, 3-phase, 60 cycles. It drives by means of a 20-in., 2-ply leather belt, a compressor which runs at a speed of 65 r.p.m. The freezing tank is 21 ft. 4 in. by 58 ft. 6 in., well insulated and containing 9100 lineal feet of 1¼-in., wrought-iron expansion pipe, and holding 432 300-lb. cans, placed 14½ in. centers.

By means of a 3-in. waterproof belt, driven from a 5-hp., single-phase, 110-volt motor, a double end circulation propeller is operated at the end of the tank, and a wooden partition down the center insures that the brine shall circulate throughout the entire tank. For hoisting 2 cans at a time, a ½-ton Sprague Electric hoist is provided, driven by a 220-volt induction type motor, and after hoisting, the ice is thawed in an enclosed sprinkling dump, 2 cans at once. For storing the ice, brine is pumped from the freezing tank by a 2-in. centrifugal pump, driven by a 2-hp. motor at 1750 r.p.m.

Air for agitating the raw water in the cans is furnished by a Root rotary blower, driven by a 15-hp. induction motor, at 220 volts, and running at 1140 r.p.m., the air passing from this blower to a receiver, where it is washed, then through a dryer and separator to the east end of the freezing tank, where it branches 3 ways, a 1½-in. pipe running parallel down each side of the last row of lids, and a 2½-in. header down the center between the 2 rows of lids. These headers are lowered into the frame, so that they lie level with the tops of the lids. The cans are arranged in the tank 16 cans wide, so that the outer headers take care of 4 cans, and the center header of 8 cans, 4 on each side.

Raw water comes from the City Water Co., and is very soft as compared to the deep well water obtained by pumping. A 2-in. main supplies the water from the city main 1200 ft. away, and the water is passed through a sand filter, then flows by gravity through 8 ft. of sharp sand into a 6-ton cooling tank at the plant. This cooling tank contains 885 lineal feet of 1¼-in., galvanized-iron expansion pipe, and after cooling here, the water is taken into the cans through 2 1¼-in. can fillers. Immediately when empty cans are placed in the bath, a 1¼-in. pipe connected to the main header is placed in each can before the can fillers are started, and thus the formation of an opaque film on the surface of the block is avoided. After the can fillers start, this temporary air pipe is taken out and 4 ¼-in. drop pipes are placed and attached to the main header. When the centers are nearly closed, the air pipes are removed and the remaining water with impurities is sucked out, the centers then rinsed with distilled water, which is sucked out and a filling of distilled water put into the center and frozen in. The distilled water for the centers is obtained from the exhaust steam from the main circulating pump, a 10 by 7 by 12 Dean. Bros. duplex, and from the boiler feed pump. To supply these pumps, a 54-in. by 16-ft., horizontal tubular boiler is used; also, there is the distilling apparatus, consisting of 2 5-ton, vertical condensers, an Austin oil separator, a York re-boiler, 5-ton mechanical filter, and a 2-ton sweet water tank. As the boiler is large for the duty that it has to perform, the steam line is throttled by a Dovic reducing valve, to 40 lb., thus permitting the engineer to refill centers, take care of his own firing, and keep in touch with all parts of the plant, because the boiler requires comparatively little attention.

Cooling water for ammonia and steam condensers and boiler feed is obtained from a pond on the ground, which is filled by city water and rain. The water is taken from one end of the pond and returned to the other, and does not often go above 90 deg. F. Experience shows that it does not pay to run the compressor with a light load, as the electrical consumption is practically the same, whether there is 5 or 35 lb. back pressure, the head pressure being the same. When the brine reaches a point where it is impossible to pump a large amount of gas, it pays to shut down the machine for 1 or 2 hr. and let the brine warm up, thus permitting a large amount of gas to be handled again. This plant operates with 5 men in the busy season, and during August, the current consumed was, by the 100-hp. motor, 56 kw.-hr. per ton of ice; by the blower motor, 3 kw.-hr., and by the propeller motor, 2 kw.-hr., making a total of 61 kw.-hr. per ton of ice made. Also, there was about 150 lb. of slack burned under the boiler per ton of ice.

Effect of Impurities on Raw Water Ice

REGULATION OF AMOUNT OF AIR DESIRABLE FOR AGITATION

SPEAKING before the American Society of Refrigerating Engineers, John C. Sparks, of New York, calls attention to the fact that when using raw water to make can ice, the amount of foreign matter in solution, as well as the kind of matter, has a considerable effect on the quality of the ice, the freezing temperature, and the amount of air which must be supplied for agitating the water as it freezes. The usual impurities are sulphates, carbonates and magnesium salts.

As the crystals of ice form, the soluble mineral salts, which are less soluble in the frozen water than in the unfrozen, are taken up by the unfrozen water, thus increasing the density of the remaining liquid. This happens with salts which are truly soluble in water; but most waters contain carbonates of lime and magnesia, which in themselves are insoluble. In the presence of free carbon dioxide, however, the combination of the salts with the carbon dioxide renders them soluble. In the course of the air agitation, the carbon dioxide is driven off from the surface of the water with the free air which is in solution in the water, thus leaving the salts insoluble and permitting them to be precipitated. It is thus possible, by using a sufficient amount of air agitation, not only to drive the air in solution in the

water, but also to precipitate those salts which might freeze into the ice to form a bad-looking cake. These salts, which go out of solution, will tend to collect towards the center of the can, and this core of heavy water must be withdrawn and replaced by fresh water, in order to get the satisfactory closing in at the center.

Experience has shown that additional air agitation is needed; first, as the liquid becomes more dense, due to the concentration of the mineral salts, and second, due to the lower temperature required in order to freeze the denser liquid.

Mr. Sparks advocates the use of a pressure gage on the air main, near the point where the air is delivered to the can, so that this can be compared with the brine temperature in the tank. As the brine temperature is lowered, so that the freezing process is hastened, a greater amount of air agitation is necessary. Also, the greater the amount of impurities in the water, the greater will be the amount of air required. Carbonates, which are the main cause of difficulty in the use of raw water for ice making, are comparatively easily removed; but sulphates and magnesium salts are apt to render the ice spotted, and an excess of magnesium salts, which it is difficult to remove, will render the water unfit for use for ice making. In cases where there is a large amount of carbonates and sulphates, the water must be treated and filtered before being used for ice making, and this will require, of course, a careful analysis of the water, and proper proportioning of the treatment to get the desired result.

As a result of experiments, Mr. Sparks gives as the basis on which to establish the air needed for agitation, that with a good water, low in mineral salts, in a 300-lb. can, with brine temperature of 14 deg. F., 6.5 cu. ft. of air are needed per minute. The pressure which will be required to furnish this will depend, of course, on the depth of the can, and taking dimensions of 11 by 22 by 44 in., for a 300-lb. can, filled to 3 in. below the top, and with the air tube inserted to 12 in. from the bottom, the pressure of water against the outlet of air is 29 in., which amounts to 1.07 lb. per sq. in. The rotary blower will furnish from 3 to 5 lb. pressure at the blower, but the friction in the transmission pipe and the cooling will reduce the pressure at the supply point by about 0.5 lb. The number of cubic feet of air which will be delivered into the can, can be seen from the table herewith, and in figuring the gage pressure

Flow of Air Through Air Inlets to Cans
(Cubic feet per minute.)

Diam. in Inches	Gauge Pressure in Air Header—Pounds. 1.	2.	3.	4.	5.
1-64	0.027	0.038	0.046	0.052	0.059
1-32	0.107	0.153	0.188	0.215	0.242
3-64	0.242	0.342	0.471	0.508	0.545
1-16	0.430	0.607	0.750	0.857	0.965
3-32	0.97	1.36	1.68	1.93	2.18
1-8	1.72	2.43	2.98	3.42	3.86
3-16	3.86	5.42	6.71	7.21	8.71
1-4	6.85	9.74	11.9	13.6	15.4
3-8	15.4	21.9	26.9	30.4	34.6
1-2	27.	39.	48.	57.	67.

in the air header, the measurement should be taken near the delivery pipe and not at the blower, for the reason that there is drop, as already stated, and the pressure indicated by the gage should be that as shown in the table plus the head due to the depth of the water in the can.

The standard amount of air, 6.5 cu. ft. per min. for each 300-lb. can, is safe, if the water contains not to exceed 4 grains of total solids per gallon. If there is more than this, the air supply should be increased on the following basis:

Mineral Salt.	Safe limit of ordinary agitation. Grains per gallon.	Increase in cu ft. per minute for each grain per gallon above safe limit.
Calcium carbonate	5	0.55
Calcium sulphate	3	0.35
Magnesium carbonate	3	0.65
Magnesium sulphate	1	0.80

If the salts in solution are mixed, it will be safe to drop the initial air per minute for each 300-lb. can to 5, instead of 6.5 cu. ft.

If the rate of freezing is increased without increasing the air agitation, there is likelihood that some of the liberated salts will be frozen into the ice, giving it a spotted appearance, and Mr. Sparks has found it best to allow 0.15 cu. ft. of air per minute additional for a 300-lb. can, for each drop of 1 deg. F. below 14 deg. in the brine temperature.

In cases where water is treated before being filled into the can, the matter in suspension and that which is precipitated from solution must be filtered out, and care should be taken that the filters are regularly cleaned, as otherwise they will become clogged and much suspended matter will be carried into the cans and frozen into the ice.

Brine Circulation and Economy

IN the May 1 issue of Practical Engineer, Mr. Hawkins gives records from a small ammonia compression plant to show the gain in ice-making capacity by allowing the brine circulating pump to operate continuously. He states that with the brine pump stopped when the compressor is stopped, the plant will be making ice at its rated capacity, or any proportion of this, depending on the number of hours the plant is in operation. On the other hand, with the brine pump left running, the remainder of the 24 hr. after the compressor is stopped, a gain of 28.5 per cent of ice is realized.

According to this, it would seem that all that has to be done, in this particular case, is to operate the compressor a predetermined length of time.

Mr. Hawkins states that this is a material gain, as it is not necessary to operate the compressor as many hours as when both compressor and brine pumps were stopped at the same time.

He also states that it would take longer to reduce the temperature of the brine to a given degree with the circulation left on. This might appear, to some, to be a contradiction of the previous statement.

While I am well aware of the increased efficiency by keeping the brine in circulation in a freezing tank, I do not clearly understand the material gain as it is put forth by Mr. Hawkins. As ice making is one of the many applications of refrigeration, the best basis for comparison, in this case, would seem to be the ton of refrigeration, which means the removal of heat at the rate of 284,000 B.t.u. per 24 hr.

The actual ice-making capacity of an ammonia compressor may be taken as approximately ½ of its rated

refrigerating capacity, but the tons of refrigerating effect equivalent to a ton of ice made in any case, may be readily calculated if the number of pounds of brine that is circulated per minute is known. Divide the continued product of the number of pounds of brine circulated per minute, the number of degrees the brine is cooled through, and the specific heat of the brine, by 200, and the number of tons of refrigerating effect can be obtained.

If possible, I would like to see some figures along these lines submitted by Mr. Hawkins, showing the cost per ton of ice made under both conditions of operation. If the brine is allowed to warm up through a considerable range of temperature, it will take a certain amount of refrigerating effect to reduce the temperature to that at which the brine is maintained when the compressor is in operation. This refrigerating effect will be equivalent to the tons of ice made during that time, and the process will have to be repeated as often as the brine warms up to a certain temperature.

It costs something to operate the brine circulating pump and I would like to have it shown whether the apparent gain in ice will warrant its continuous operation. If a material gain can be realized by this means, it should be of interest to engineers who are operating small plants, say from 1 to 10 tons capacity, and which are operated to their full capacity only during the summer months.

As Mr. Hawkins is familiar with the plant cited, it should be easy for him to present some data, which I am sure will prove of value to all readers who are interested in the subject.

The plant to which the writer referred in the April 1 issue of Practical Engineer, and in which also a sketch was given, showing the arrangement of brine piping was, at that time, operating under unusual conditions. There was no one in attendance at the plant through the night, and this was one of the reasons why it was thought advisable to preserve the brine temperature as much as possible. It was also feared that, should the temperature rise to 32 deg., some of the ice cans might be spread and the results might be leaky cans. At that time, nothing had been insulated, but the freezing tank. Ten tons of ice had to be gotten out of the tank in about 14 hr., and delivered to the old plant, a considerable distance away. Everything that was favorable to getting an early start was taken advantage of. It will be noticed that this freezing tank is used in connection with a brine cooler, which acts as a "booster" for the brine, and makes a very efficient arrangement.

Being well acquainted with the condition of affairs at this plant, at the time, I readily agreed with the engineer in the attitude he took in regard to closing the valves A and B. W. S.

IN A PAPER on Resins in Coals, from the U. S. Geological Survey, it is shown that lumps of resins buried in the peat formations of early ages are found in brown lignites and subbituminous deposits, forming, in some cases, a large part of the coal. In the older coals, the resin is present, but much of it has been transformed by chemical and mechanical action into material much like the remainder of the coal and in finer particles. The presence of a large proportion of resins would result in a large percentage of volatiles in the coal.

Progress of Department of Machinery, Panama-Pacific Exposition

EXHIBITS at the Panama-Pacific Exposition will comprise one of the finest collections of electrical and machinery exhibits ever assembled under one roof and the exhibitors are cooperating with others, which will permit of complete operation and demonstration of the working of the various machines and electrical exhibits.

On April 1, preliminary work was started on the installation of the first exhibit, a 500-hp. marine Diesel engine, by the Busch-Sulzer Brothers Diesel Engine Co., and the first pile for the foundation was driven with appropriate ceremonies on May 27, by Captain Asher Carter Baker, U. S. N. (Retired), Director of the Division of Exhibits. The installation will cost $70,000.

The entrances to the Palace of Machinery will be handsomely decorated with palms and shrubs and to attract the nontechnical visitor many spectacular exhibits have been arranged. Several of the exhibitors have arranged beautiful and artistic effects, such as waterfalls and illuminated fountains.

The latest and most modern-approved methods of illumination will be displayed, of especial interest being the isolated electric-house-lighting systems for farm use, compared with the most complicated systems in use for city lighting.

All of the working exhibits—and it is now certain that a large percentage will be in actual operation—will be equipped with the latest "safety-first" devices and these guards will form one of the most interesting exhibits to the engineer and manufacturer.

The gates of the Exposition will open on Feb. 20, 1915, and will close on Dec. 4, 1915. Nine of the 11 principal exhibit buildings are now complete, and the others will be finished within 30 days.

A Prayer

O POWERS that be, make me sufficient to my own occasions.

Teach me to know and to observe the Rules of the Game.

Give me to mind my own business at all times, and to lose no good opportunity of holding my tongue.

Help me not to cry for the moon, or over spilled milk.

Grant me neither to proffer nor to welcome cheap praise.

When it is appointed for me to suffer, let me, so far as may humanly be possible, take example from the well-bred beasts, and go away quietly, to bear my suffering by myself.

Give me to be always a good comrade, and to view the passing show with an eye constantly growing keener, a charity broadening and deepening day by day.

Help me to win, if win I may; but—and this, O Powers! especially—if I may not win, make me a good loser. Amen.—Robert Frothingham.

LETTERS DIRECT FROM THE PLANT

Cash Paid For Ideas Accepted. Sketches Desirable.
We Make The Drawings

Serviceable Home-Made Draft Gage

ACCOMPANYING drawings represent a draft gage constructed by the writer. Figure 1 shows an elevation of the gage with the cover removed. Figure 2 shows the connection for calibrating the gage with an ordinary U tube gage. Referring to Fig. 1, A is a light can suspended bottom up inside of the can, B, A being suspended as shown by cord, D, on segment, C, of lever, E. This lever is pivoted at E, and has a weight, H, to counterbalance the can A.

The lever is constructed of a piece of No. 8 wire, with a V notch filed on the segment, C, to receive the cord, D.

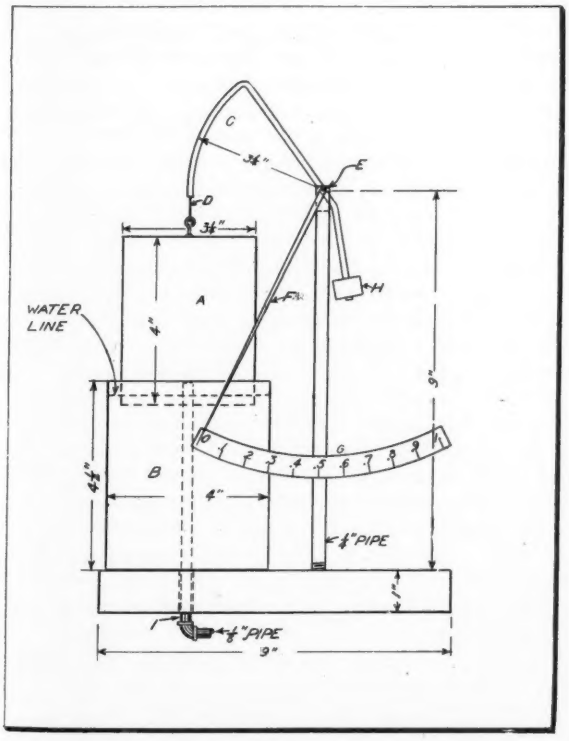


FIG. 1. DRAFT GAGE WITH COVER REMOVED

Through the bottom of can B, is a piece of ⅛-in. pipe, and the pipe is soldered to the bottom of the can. This pipe should reach to the top of the can, the lower end of the pipe being connected to the flue or furnace as desired. The can B, is filled with water to near the upper end of the pipe, as shown. F is a light pointer soldered to pivot at E and can be of any convenient length; this pointer indicates the draft in inches of water on scale, G. If can A is made the diameter shown, it will have a vertical movement of about 3 in. for 1 in. draft.

To calibrate the gage, connect as shown in Fig. 2, K being an ordinary U tube gage.

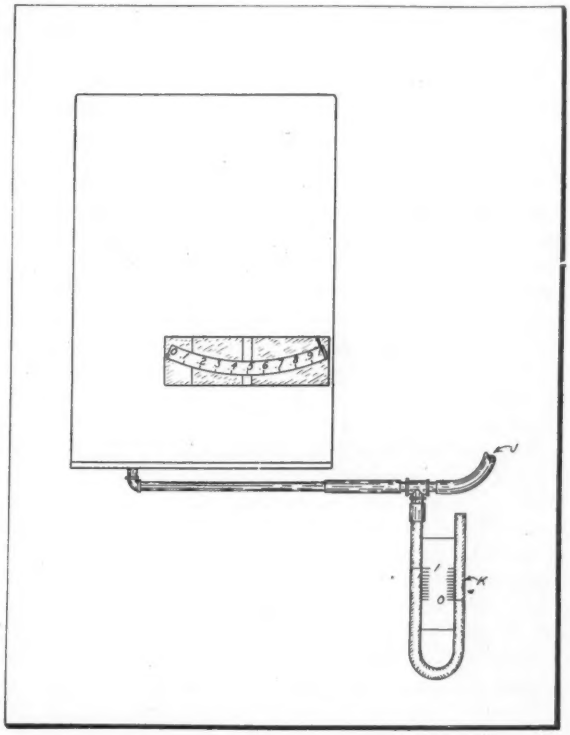


FIG. 2. CALIBRATING THE DRAFT GAGE WITH A U TUBE

By inserting the rubber tube, J, into the mouth and drawing air from the tube, the gage, K, will register in inches of water, the scale, G, being marked at the corresponding position of the pointer, F. R. L. MOSSMAN.

Blowing Down Boilers

IN REGARD to blowing down boilers, as discussed by Frank Bohe, in the issue of May 15, I don't think many will adopt his plan. If he works his boilers to full rated capacity, in the neighborhood of 400 lb. of sediment will accumulate in each boiler every month. Instead of trying to keep the mud soft, I would much rather get rid of it. A dirty solution in a boiler not only causes it to fire harder, but is apt to induce it to foam and prime, with bad results in the engine.

I once had charge of a plant using 80-hp. return-tubular boilers. The feed water had a temperature of

about 70 deg. F. It was fed cold, through the blowoff, with any ordinary duplex pump.

Thinking to improve it, I piped through the front head, back within 3 ft. of the rear head, then across all of the tubes, but didn't turn it down because the short pipe had 2 rows of small holes on one side, which I left on the lower side. I then connected a Penberthy injector of the same size as the pipe and was more than surprised to find that the boiler fired harder than before.

Now will some of you sharks give me the reason?

At the same place there were 2 small slide valve engines, same size, same pattern, same make, and as near as I could see, they were exactly alike. One ran "over," the other "under," one had the "long" end of valve down, the other had "long" end up. At this late date I am not sure which, but I think the one running "over" had the long end up. Anyway, I tried changing it because the exhaust did not sound "square." After careful adjusting, it sounded square as you please; but it would not pull the load, so I had to change back. I have never found the reason. FRED ECKLEY.

Repairing Babcock & Wilcox Boilers

IN THE June 1 issue, I noticed a criticism by J. Powers, on Mr. Solomon's article on cleaning and repairing B. and W. boilers, published in the Feb. 1 issue.

Mr. Powers claims that it is not necessary to remove any tubes except the defective one, which he says can be taken out without the aid of a pipe cutter by any good boiler maker that follows the usual procedure of cutting and bending in at the headers and pulling the tube through the hand-hole.

Now, this sounds nice and looks easy on paper; but pulling an old blistered, bagged and scaly tube through a hand-hole is a tough proposition. We will assume that the defective tube is in about the center of the boiler and in the fifth row from the bottom. We commence by ripping and bending in the tube at both ends to get the tube through the header far enough to fasten a strap on it to pull the tube out with; we will have to butt the other end of the tube with a piece of shafting or something similar. As soon as the tube is bumped or pulled out of the back header, it falls down on or between the next lower row of tubes; consequently, the tube is cocked in the front header; some provision must be made to hold up this tube so that it can be withdrawn somewhat square with the opening in the header. When we come to a bag or blister we must rip the tube and cave in the bag or blister in order to pull out the tube. We will assume that the tube has been cut off just outside the hand-hole on the front header and we are going to rip the tube back beyond the header and cave it in.

First, there must be some means of holding the tube while the ripping is going on, the means for holding the tube firmly will no doubt be cumbersome and in the way.

The next thing is to cave in the tube so that it will come out; that is going to be a job. It might be easily done on a type of header where there is room to swing a hammer; but in the header under discussion there is no room to swing a hammer.

Probably Mr. Powers means to rip the tube back as far as possible and pull the tube out by means of a chain fall or block and tackle. This will put an undue strain on the header; besides, the tube will cut and score the header opening on being withdrawn in this manner and the next tube that is put in its place, will leak at the header on account of these grooves and scores. This opening should be round and smooth as possible so that the tube will make a good contact with the header all around after being rolled in place.

In my varied experience with B. and W. boilers in the case of blistered and bagged tube removal, I have always found it cheaper, quicker and better to cut the tube in two somewhere near the center with a pair of chain pipe cutters and pull the 2 tube ends into the furnace, where it can be easily taken out. If the tube has been up a few rows from the bottom, I have always cut out enough tubes so I could get at the defective one.

I have worked in plants where the feed water conditions were so bad that we averaged from 3 to 7 tube renewals a day and there was no time to waste in renewing tubes, as the boiler plant could hardly supply steam enough when going full blast; consequently, any boiler that had to be shut down crippled the plant, which meant a large loss to the firm. In this plant, time was worth more than any expense. C. E. ANDERSON.

Balancing A Steam Turbine

N. G. NEAR'S LETTER in the May 1 issue makes balancing of steam turbines, just like shifting claims; unfortunately, however, he witnessed a very simple case; sometimes each end is out of balance at different points and, as an old erector and test plate hand, I can assure Mr. Near it's not always so easy. The writer can not for the world think what turbine builders are using 2-lb. balance screws in a coupling, as the best practice is to use as small a weight as possible at the largest diameter and for this purpose, on Parsons type machines, each end of the rotor has a series of holes drilled around its end disks, and of course disk machines all have the disks balanced separately so that any final unbalanced portion is looked after in the last disks at the ends.

Why the coupling, which would probably be 3 ft. from the end of the turbine drum, should carry the balancing plugs I don't know, unless this was a very high speed machine with a large diameter coupling and the coupling was the out-of-balance part.

We used to hold a colored lead so that it just touched the high portion of the shaft when running and then shut down, take a point opposite the heavy marking of the lead and, for moderate speed machines, try the first balance weight 20 to 30 deg. behind the point opposite the heavy marking, as the heavy point in running balance will be found to lead the light by the above amounts, depending upon the speed of the machine.

The amount to add without making elaborate calculation is a thing which can be judged only by experience.

As a warning to anybody making his first running balance, I would advise him to get 2 sheets of paper, draw circles upon them, keeping one at each end of the machine, carefully marking each weight upon the paper with a note as to effects, and be careful to add only very small amounts at a time until, by knowing the diameter of the rotor and speed, one is fairly able to judge the approximate weight by the intensity of the vibration. E. R. PEARCE.

Repairs to Jet Condenser

THE FOLLOWING description of repairs to a vertical, twin beam jet condenser with 26-in. water cylinders may interest readers of Practical Engineer.

The pump in question needed new linings, so it was taken out and sent to the shop a few miles away for repairs.

During the process of taking out the old linings, it was discovered that the bottom valve plates were badly corroded and were not in condition for further use. The plates were of iron and cast integral with the cylinders, and had been attacked by chemicals discharged from a neighboring dye works and drawn in with the injection water.

It was decided to replace the iron plates with new ones of bronze, so the old plates were knocked out and the cylinders bored a few inches farther to allow for new linings longer than the old ones.

New bronze plates were cast, having grids across the bottom to increase the strength and a flange about 2 in. high around the circumference; these were turned to fit the inside of the new linings and were driven down into place inside the linings and the flanges, linings and cylinder walls were drilled in 8 places in each cylinder for ¾-in. bronze studs to hold the valve plates in place.

Those holes coming in the wall between the 2 cylinders were tapped for tapered studs, as the cylinders were cast on one base and there was not room enough between them to head the studs as was done with the remaining ones.

In due time the condenser was placed in operation again and after about 2 months the operator discovered that one of the plates had become loose and was working up and down with every stroke of the bucket; however, it was kept in service until the next morning, when a man was summoned from the shop and the loose studs were replaced, 2 or 3 new ones being added. It was also decided to place some means of support under the plate. A suction box, common to both cylinders, extended the full length of the base, the space between the bottom casting and the under side of the valve plate being about 6 or 8 in. Four holes were drilled in the valve plate large enough to pass a ⅞-in. bronze stud and by means of a long drill passed through these holes, other holes were drilled in the casting forming the bottom of the suction box directly in line with those in the plate. These latter holes were tapped with a long tap passed through the holes in the plate; the narrow space and small hand-hole in the suction box made the use of long drill and tap necessary.

The holes in the bottom casting were tapped with a tapered thread to receive the bronze studs, having a tapered thread on one end and a standard thread on the other; these studs were ⅞-in. in diameter and long enough to screw into the bottom casting and extend through the plate far enough to allow for a nut.

Bronze sleeves just long enough to reach from the bottom casting to the under side of the valve plate were now put in place in line with the holes in the plate and bottom casting, the tapered thread on the studs coated with a paste of glycerin and litharge, and the studs slipped down through the hole in the plate, through the sleeves and screwed tight into the bottom casting, nuts were placed on the studs where they extended through the valve plate and when these were set up the job was complete.

The condenser has been in service several months since the latter work was done and shows no further signs of weakening.

In tapping out the holes in the base casting, the tap was broken off flush with the surface and it looked like a bad job to get it out; after a few moments, a piece of ½-in. pipe about 12 or 14 in. long was secured and 4 slots cut in the end, leaving 4 projections narrow enough to slip down over the flutes of the tap. The pipe was passed through the hole in the valve plate and dropped down over the broken tap. A few moments' persuasion with a Stillson wrench backed the piece out.

C. B. HUDSON.

Troubles With Water Column and Piston Rod

AT ONE time, while going through a steam power plant, I noticed many things that were not as they should be.

The upper joint in a safety water column leaked badly. This is bad practice, as any leak at the water column or gage glass will show a false water level in the boiler; it is an easy matter to repack this joint at boiler washing time. What good is there in having a safety water column if it is not in good working condition?

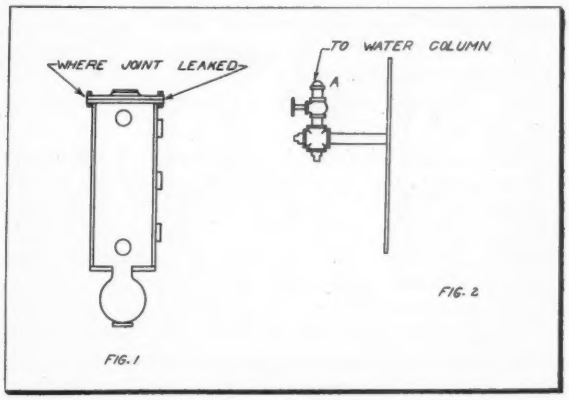


FIG. 1. SAFETY WATER COLUMN SHOWING LOCATION OF LEAKY JOINT

FIG. 2. WATER CONNECTION TO WATER COLUMN

Another bad point was in the way the water column was connected up. It will be noticed in Fig. 2 that the globe valve in the water connection is in the vertical pipe leading to water column; there is no way to clean this pipe out with a rod, due to the globe valve. A better plan would have been to use a gate valve in place of the globe valve, or, a still better plan, to place an angle valve in place of the elbow, A, leading to the water column, thereby doing away with a number of joints.

It also would have been an easy matter to run a rod through any of the pipes to remove any hard scale.

The piston rod on a high-speed engine, which is direct connected to a generator, leaked badly and, no matter what kind of packing was used or how care-

fully the packing was placed in the stuffing box, the rod was bound to leak. This engine had been wrecked shortly after it was installed, due to a dose of water in the cylinder. The engine was put in working condition again; but after this there was trouble with the piston rod leaking. Some time after the engine was in service again, it was found that the rod was bent a little, which was the reason that it could not be kept packed tight for any length of time. After the rod was straightened, there was no more trouble.

H. JAHNKE.

What's the Value of Examination Questions?

FOR A long time I've been wondering "why" as regards some of the questions asked by license boards, and have, as yet, found no satisfactory explanation.

One of the things which has long puzzled me is this: Why is an engineer, who is not supposed to be either a boiler maker, manufacturer, or inspector, compelled to know the tensile, ductile, etc., strengths of various boiler steels, etc., when, no matter how great his knowledge on the subject, some inspector with half the brains he has can and does exercise greater authority over the pressure carried, boiler details and general management than can the engineer himself?

It so happens that I once knew several men taken from the engine room and made examiners in a certain eastern city, all good men and true, capable of handling any plant in existence, and doing so successfully, and to my certain knowledge two of them used a trade school's books whereby to get their technical questions to bewilder the applicant for a license, questions that, were the positions reversed, they themselves could not answer offhand.

Yet they invariably placed this as against the credit of the applicant, and on one occasion I asked my friend, the inspector, "why," since I personally knew that he could not answer a certain set of questions. (Still, I knew that, put to a practical test, he would not have been bothered one moment in doing the job; while, to save himself, he could not have given an explanation that could have been understood.) He replied that, simply because he was himself to a certain extent ignorant, that did not excuse him for neglecting his duty to the public by passing a man equally ignorant.

It seemed to me at the time that the answer was rather vague, and though that occurred many years ago, I am still wondering just what he meant.

If a man were applying for a license allowing him to operate as a boiler inspector (and why shouldn't a boiler inspector have to have a license as well as an engineer?), then these questions regarding the details of construction of boilers and their various strengths would be appropriate; or, should it be a manufacturer of engines or other machinery, why should his knowledge not be compulsory and he be allowed to operate only under a license also?

What does it avail me to know that frame or bedplate of my engine is too weak to stand the jar and shock of the intermittent loads thrown on and off, or that the crank-shaft is too light, when the manufacturer says it is all right and so guarantees it for one year? (I may have to stand by the old rip for 20 yr., and it's a cinch the last 19 are as important to me as the first one), and his knowledge and one year guarantee is taken against mine? Ninety-nine cases in each hundred, the owner would say that the engineer was over-cautious, or, worse yet, a plain fool.

Then, the great number of questions asked as to this or that make of governor, valve gear, or boiler—"why"?

There are hundreds of types of engines which I have never seen, yet I am confident that with 5 hours' time applied to the cross-sections, diagrams and other printed matter of the manufacturer of any engine, combined with my practical and somewhat limited technical knowledge of the subject, I can take charge of and operate successfully any engine or boiler.

The examiner often forgets that he and I were not raised on the same type engine and he will always ask questions as regards the machines with which he has had the greater experience, a fact which is evidenced by no 2 examiners ever asking the same questions about the same brand of "critters."

And "why" if a man is known, and can be vouched for by long knowledge, to be cool, steady and reliable, is he not capable of handling a plant of 1500 hp. as well as he can one of 150 hp.?

Is the special knowledge more essential too for the safety of 5000 women and children working in the large factory than it would be to protect the 500 of them working over across the street in the smaller place?

I had a question asked me 18 yr. ago, and only a few days ago I saw the same question mentioned again in one of our steam journals; it was this: "If you were operating a boiler where there were no tools to be had and found a crack several inches long in the head, what would you do to make it as good as new, and as strong?"

Now isn't that a bright question?

My reply was just as idiotic, for I said: "I'd put her on the skids and ship her to the factory to be fixed," and great indeed was my surprise when I found that I had it right, for I had not made the answer thinking of the absence of tools or anything of that sort, but simply because I didn't know what I'd do more than a baby, for at that time I was mighty new at the business, having just got over my apprenticeship.

One could go on and on, and it simply comes back to whether we want Huerta or Villa—it's war anyway between the examiners and the engineers, and Sherman's definition of war is correct.

JOHN PIERCE.

STEEL BELTS are being introduced in England to a considerable extent, for the driving of textile mills, where the production of fine yarn requires steady, regular drive. The power transmitted varies from 10 up to 3650-hp. drives, the belt being made from a specially hardened charcoal steel, having a tensile strength of 95 tons to the square inch, and no perceptible elongation under load. The thickness does not exceed one millimeter, and the width is but 1½ to 8 in., according to working conditions and power to be transmitted. The rims of pulleys are covered with a layer of canvas, to which are glued thin sheets of cork, and the coefficient of friction between belts and pulleys so covered has been found to be 0.27, which is practically equal to that between leather belts and iron pulleys.

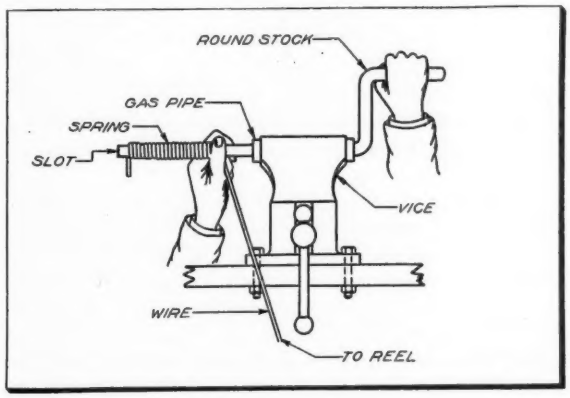
Successful Kinks From The Plant

For Saving Time, Work and Trouble

Simple Method of Winding Springs

WE USE quite a number of springs of different sizes. Before I made the devices for different sizes, they were made by clamping with a lathe dog to arbor of size wanted and arbor put in lathe and for small music wire 1/64 up to 1/16 could be held tight enough with the hand, but on wire 1/16 or over a clamp had to be used between spring and reel.

We have made springs for a Peerless lacing machine with this device, with tempered and soft wire. For making a compression spring, it is best to wind wire close and stretch to suit the condition. A very large spring can be made of soft stock and tempered afterward by putting gas pipe in below the jaws of the vice. In making a spring of soft stock, use a rod the size of hole in spring desired. In making a spring of tempered



SPRING WINDING DEVICE

wire use a rod about ⅓ smaller than the hole in the spring desired, as I have found by experience that the tempered wire will spring about that much. The method of making the springs with a lathe and the device are the same, only you turn the device with your hand and the work is done quicker with it. W. A. JONES.

Steam Jet for Heating Water

FIGURE 1 shows a live steam jet for heating sea water which I made, to warm a 150,000-gal. swimming pool. We formerly heated this water by pumping it through a surface condenser as condensing water, but the pump, a 10 by 10 by 12-in., when running rapidly, as when filling the pool, would continually break the condenser tubes, letting the salt water into the hot well and thence to the receiver of the boiler feed pump, causing the condenser to be bypassed.

I took a 1¼-in. brass pipe 12 in. long and cut a thread the whole length, then I took a hacksaw and sawed into the pipe diagonally as shown, which made an opening like a crescent. At first I made 8 openings, and tried it out and found that it worked well, but gave a little chattering similar to a light water hammer, so I took it out and sawed 12 openings, and after this the 1¼-in. valve could be opened wide with 80 lb. steam into the cold sea water at 35 deg. and give no hammer or noise at all.

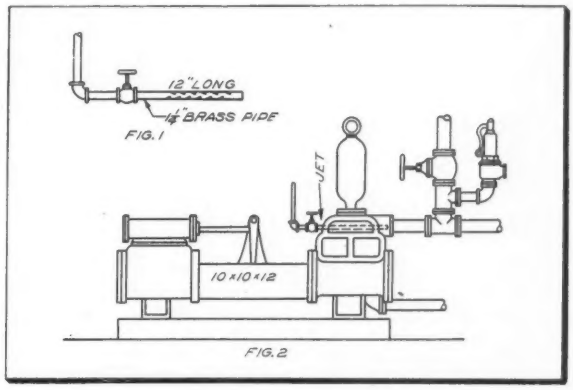


FIG. 1. STEAM JET FOR HEATING WATER
FIG. 2. LOCATION OF STEAM JET IN PUMP DISCHARGE

The jet is shown in Fig. 2 screwed into the top hood under the air chamber and extends 12 in. into the discharge pipe. It is necessary to saw these holes diagonally so that steam will easily drag the water with it, while, if straight holes were bored, the steam would be inclined to force out through them and cause hammering. "STA BLT."

Flue Scraper Handle

HAVING HAD a great deal of trouble to get a good, straight, strong wood handle for flue scraper, I hit upon the following scheme: I went to the lumber yard, purchased 4 pieces of quarter-round, ¾-in. size, 16 ft. long, took off the corners of each piece about 14 in. from one end, purchased some 1¼-in., No. 9 wood screws, bound the 4 pieces of quarter-round together, set a cabinet clamp the correct size so that the edges came right, and put wood screws about 8 in. apart, on opposite sides the length of the sticks, put a piece of ½-in. pipe in the arch, heated it and burned out the ends. I took the corners off, riveted in the pipe, bound with No. 14 galvanized wire, and had a flue scraper handle large enough to get hold of, stiff and not too heavy.

L. W. GREENE.

Pump Valve Seat File

THE WRITER found a duplex pump in one of his plants, running as a boiler feed pump. Though it was old, it worked well on the steam end, but the water end would wear out the composition valves and there was much loss due to leakage under them. The manager would not have it repaired, as he considered that it was pumping water and did not require any repairs as long as it moved at all. There were no tools available to face up the brass grid seats or to remove them to be faced up in a lathe; with a proper cutter, they could be machined easily while in place.

Getting tired of putting in valves to replace the worn and broken ones, I finally hit on the following plan. We had some old double cut, smooth files which I made use of. I took an old composition valve and cut a channel across one side with hack saw, dove tail in form, and ground the edges of the file to a bevel, smoothing the under side slightly, making 2 pieces, the ends coming in snug to the valve bolt, fitting very tightly in the recess. Figure 1 shows the face side and shape of files. From the junk box was obtained a crowfoot, formerly used on a goose neck electric lamp support, which was screwed on the back side of the valve to form a

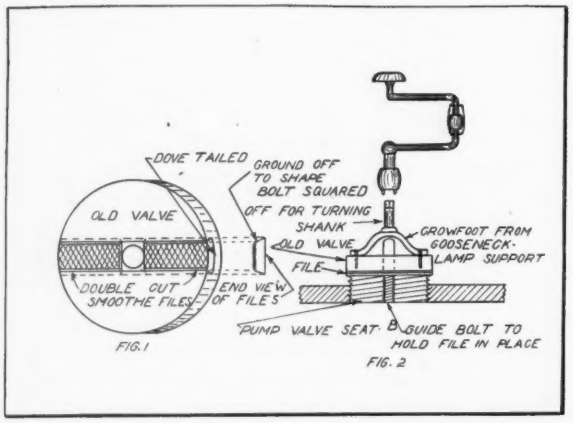


FIG. 1. FACE OF VALVE RESEATING TOOL

FIG. 2. RESEATING TOOL IN POSITION FOR OPERATION

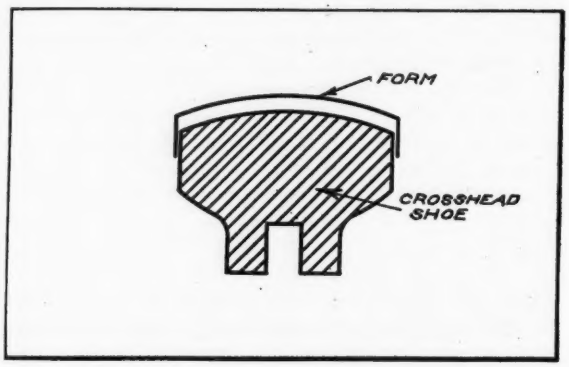
yoke, and a bolt screwed into it, riveted over, and the other end filed off square, making a shank for turning, as a wood bit, with a brace.

Figure 2 shows the device in position for operation; B is a short, headless iron bolt, which is screwed into the valve seat in place of the valve bolt, to act as a guide and keep the file in positon over the valve seat. It is not a hard tool to make and will save much slippage and the use of a great many valves, if used often enough to keep the grid seats in good condition. But where metal valves are used, they require to be ground in with quartz or fine sand, preferably grindstone grits, after they have been faced up; however, in pumps of large size with many valves, this tool is insufficient, as the top of the suction and discharge chambers cannot easily be removed, and it is far better to remove the valve seats, as plants using large pumps have tools for removing the valve seats. Some may be pressed into position, while others are screwed in place. Where there are many pumps in the plant, it is more economical to get a set of valve reseating tools, and the seats can be trued up without the hard labor of removing the seats.

We can readily see, from the contrivances which are made to meet emergencies, that it is not always good policy to dispose of the apparently worthless scrap in the junk pile. It frequently pays to keep some of it on hand. R. A. CULTRA.

Babbiting Crosshead Shoes

THE CROSSHEAD of one of our engines was making a clicking noise at the end of the stroke, and upon examination, we found the babbit loose. As it was worn considerably, we decided to babbit it. The guides were bored to a circle, and as we had a lathe, we thought it would be better to babbit the shoes with a form and then turn them off in the lathe. A form of sheet iron was made



SHEET IRON FORM USED IN REBABBITING CROSSHEAD SHOES

that slipped over the crosshead shoe, that is, the portion to be babbited, keeping it away about ¾ in., allowing enough metal to turn off. The shoe was stood on end and poured. Metal was then well pened with a hammer. A mandrel was made, for a center for the crosshead; the shoes were assembled and turned off. The oil grooves were then cut, the shoes were scraped, and the crosshead was placed in the guides and connected up again. This method made a much better job than to pour the metal with shoes in the guides, as when this is done the metal chills quickly. TOM JONES.

TO PREVENT DECAY in timbers, experiments have shown, as stated by F. J. Hoxie before the National Association of Cotton Manufacturers, that heating to 115 deg. F. for an hour will kill the dry rot fungus. Ventilation, unless dry, will not prevent rot, as the fungus grows in moist air. Selecting the best long leaf pine timber and antiseptic treatment are the best safeguards. Short leaf lumber is specially susceptible to dry rot.

Coal tar compounds serve well for antiseptic treatment, but cold surface application of creosote is of little value, as the fungus is likely to be in deep. The compound should be so applied as to penetrate the wood. Chloride of zinc, when deeply applied, has been found to weaken timbers somewhat. Corrosive sublimate, as far as used, seems to be satisfactory, but must be handled with caution, as it is a poison.

Questions Answered and For Answer

Expert Help When In Trouble. If You Want Quick Answer Enclose a Stamp

Steam Consumption of Ship

A SHIP needs a new feed pump. Her high pressure cylinder is 20-in. diameter, 42-in. stroke, full-gear cutoff 32 in., speed 85 r.p.m. The steam she uses weighs 0.38⅜ lb. per cu. ft. To this is to be added 15 per cent for clearance and various auxiliaries. How many cubic feet of water per minute must be provided for at 61¾ lb. per cu. ft.?

2. A ship is coaled to steam 100 mi. at 12 mi. per hr., using 2000 lb. per hr. By reducing speed to 10 mi. and coal 1200, how far can she steam?

A. The area of a 20-in. cylinder is 314.2 sq. in. She cuts off at 32 in., so that we multiply this area by 32 to get the volume per stroke, then by 85, the revolutions per minute, and by 2, since the engine will be double-acting, to get the volume per minute, and then multiply this by 1.15, to allow for the 15 per cent clearance and auxiliaries. This gives us the total cubic inches of steam used. Dividing this by 1728, to reduce to cubic feet, and by 0.38,375, the weight of a cubic foot, gives us the pounds of steam used per minute. Dividing that by 61.75, gives the cubic feet per minute, which, in your case, amounts to 23.98.

2. A ship coaled to run 100 mi. at 12 mi. an hour, would travel for 100 ÷ 12, or 8⅓ hr., and this times 2000 lb. an hour would give the total steam made. Dividing this by 1200 would give the number of hours she could run under the second set of conditions, and multiplying by 10, the mi. per hour, would give the distance which she would travel, which amounts to 139 mi.

Cylinder Oil in Boiler

WOULD CYLINDER oil cause the tube ends to leak on a return-tubular boiler?

2. If called on to start a plant that had been stopped some time, you found that the boiler shell and tubes were covered with oil, such as cylinder oil, how would you proceed to get them in shape to run? They are return-tubular boilers. What effect does soda ash have on oil of that nature, cylinder oil, when used in feed water?

3. Suppose that conditions were such that it was impossible to stop all the cylinder oil from getting into the boiler, what would be the best way to counteract what did go in?

4. Which is the best heater, the open or closed type feed-water heater?

5. What are the advantages and disadvantages of each? B. S. C.

A. Cylinder oil accumulating in a boiler is quite likely to make the tube ends leak. The oil will collect in corners and on the heads, and will cause overheating of the surfaces which it coats. This will tend to cause undue expansion and contraction, and thus will be likely to work the joints between the tube heads and the ends loose.

2. Soda ash is one of the best treatments for removing cylinder oil from the boiler. Fill the boiler with a strong solution and let it stand for 24 hr. Then blow down, wash out with hot water, and if the oil has not been entirely removed, repeat the process.

3. Where it is impossible to prevent cylinder oil from entering the boiler, the only thing to do is to blow down frequently, feed soda ash with the feed water, and inspect and clean frequently.

4. As between the open and the closed feed-water heater, it all depends on the circumstances of a plant which is the better. Where there is cylinder oil in the exhaust, the closed type is better, because it prevents the cylinder oil from getting into the boiler. Where the exhaust steam is clean, the open type heater will give hotter water than the closed type. The best method for you to get familiar with the advantages of each type is to get catalogs from the different makers of the 2 types of heaters, and study their arguments and what they claim to be able to do. A. L. R.

Use of Balancing Coils

EXPLAIN HOW collector ring balances voltage on a 3-wire system. J. A. M.

A. The current generated in the armature of a direct-current generator is alternating. That is, it flows first in one direction and then in the other in the coils. At reversal, the current does not stop abruptly and then begin in the opposite direction at a maximum value, but falls from a maximum in one direction to zero, then changes direction and gradually rises to maximum value, then falls to zero, reverses in direction and rises to maximum in same direction as at first, etc. There are many reversals each second.

Before the current leaves the machine, however, it is rectified or changed into a current that is of uniform direction and value. This is accomplished by the action of the commutator and brushes.

In the Dobrowolsky dynamo, the armature is tapped at 2 diametrically opposite points, one tap being connected to each of 2 collector rings. The brushes on the rings are connected to the ends of a "self induction" coil; that is, one having an iron core. Since this coil is connected directly to the armature, and not to the commutator, alternating current is impressed upon it.

One of the properties of a coil with an iron core and supplied with alternating current is the automatic de-

veloping of a counter electromotive force called self induction. This self induction acts as a resistance to the alternating current, but not to any direct current that may pass through the coil.

At the middle point of the coil a tap is taken. Since the self induction is equal in the 2 halves of the coil, this tap is kept midway between the potentials of the direct current terminals (positive and negative) of the dynamo. It is connected to the neutral of the 3-wire system, the outer wires being connected to the positive and negative terminals of the dynamo.

When the loads on the 2 sides of the system are not equal, the difference in current passes through the tap and through one-half of the self induction coil to the armature. This is possible since this current is practically steady, and hence not opposed by the self induction of the half of the coil through which it passes.

The self induction coil may be so built into the armature as to revolve with it and to be directly connected to it. The tap is then brought out to one slip ring, the brush of which is connected to the neutral of the 3-wire system.

Furnace for Sawdust

ENCLOSED are plans in detail of settings for 72-in. by 8-ft. boilers, which may be of service to A. L. M., who makes inquiry in the May 1 issue.

The settings include dutch oven, self feed, and natural draft for the burning of sawdust and shavings.

The setting serves in a number of sawmills and, as far as my experience goes, gives good service from a steaming standpoint and general service.

I have never experienced the cinders coming from the stack, and though the combustion chamber will fill quite a good deal with the burning of sawdust, I believe the large space provided as a combustion chamber is not necessary, as boilers seem to steam quite as easily when the combustion chamber is filled to within about 4 ft. of the boiler.

In the burning of shavings in one plant that I have charge of, the chamber will not fill up to prevent good steaming, though I find that it is hard to fire so as to prevent dense smoke at times; but this I account for in this way; viz., since the blowpipe system is used for

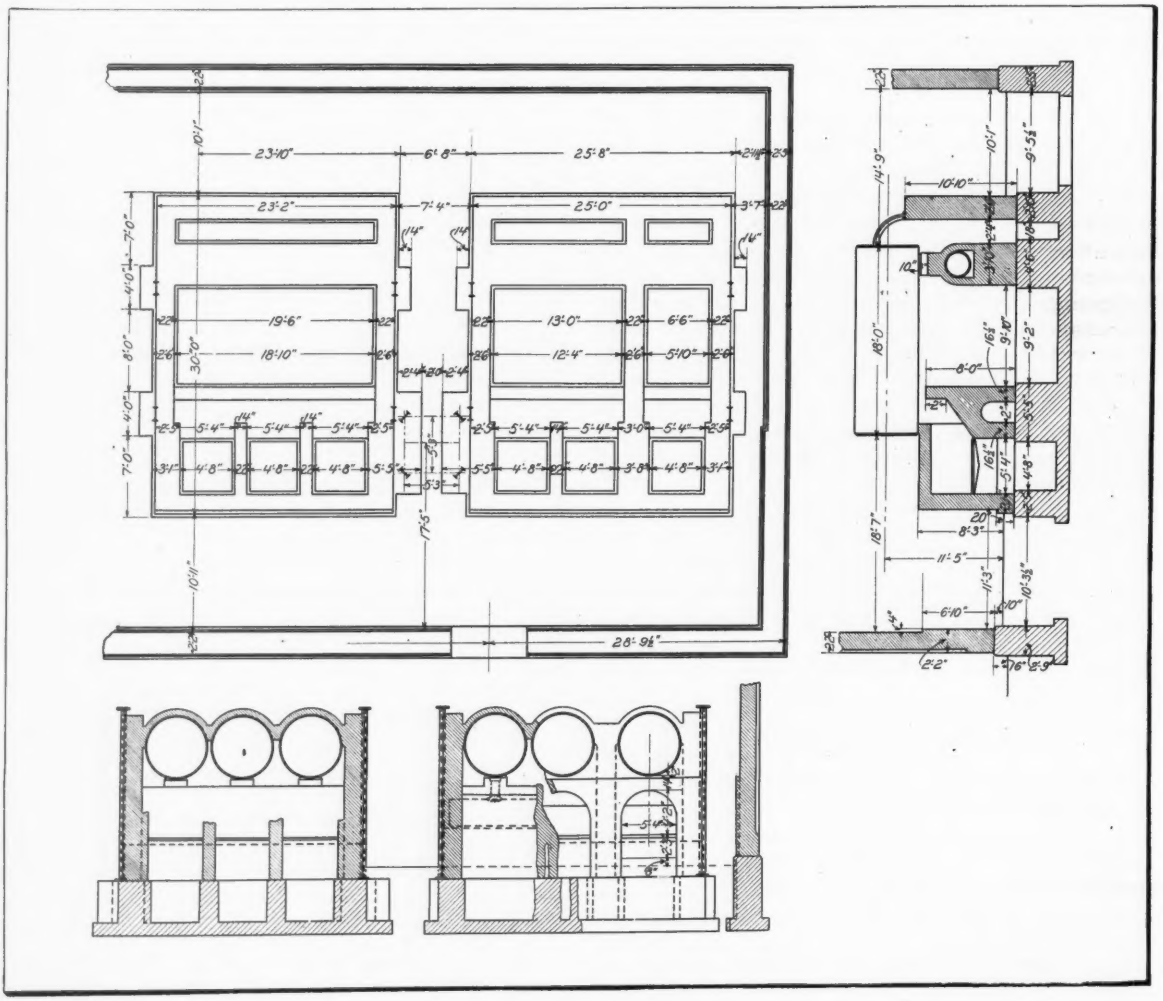


FIG. 1. PLAN OF FOUNDATION AND VERTICAL CROSS SECTIONS OF BOILER USING SAWDUST FUEL

feeding the furnaces, the flow of fuel is not steady, but comes as the machines make more or less and the switches are not set properly to feed the amount of fuel needed. You will note from print, that one hole is used. I have never had any experience with 2 holes in connection with the dutch oven.

Complete combustion is usually noticed more plainly by the absence of black smoke issuing from the stack, rather than by noting combustion in the combustion chamber.

Sawdust makes a short flame; seldom have I noticed it more than about ½ the length of the boiler on the bottom.

I use draft holes in fire doors of dutch oven closed, as the feed hole admits some air on top of the fire; also, I find that when an excessive quantity of air is admitted under the grates with a good natural draft, the sawdust will not remain on the grates, but leaves the furnace as soon as it gets to burning.

I have operated a total of 46 72-in. by 18-ft. boilers in 4 different plants, with the boilers set as illustrated, have had good service from them, and in the majority of cases the boilers would do 50 per cent over rated capacity. ROUNDER.

Solution for Condenser Troubles

IN REGARD to the trouble I. X. has, as was explained in the May 1 issue, wherein he states that his engine cylinder becomes flooded with water from his condenser, it is not a case of fitting relief valves, but of putting a vacuum breaker and gage glass on the condenser, which evidently is a jet condenser placed below or to one side of the engine. Even if 6-in. relief valves were put on, and the engine lifts water, the valves will be unseated.

Does not the water bother the most when shutting down?

It would be interesting to know the steam consumption of this engine; for, as a rule, single-cylinder condensing engines, even of short, quick stroke, are not very economical (excepting those of the central exhaust type) owing to the large variation of temperature which takes place in the cylinder. E. R. PEARCE.

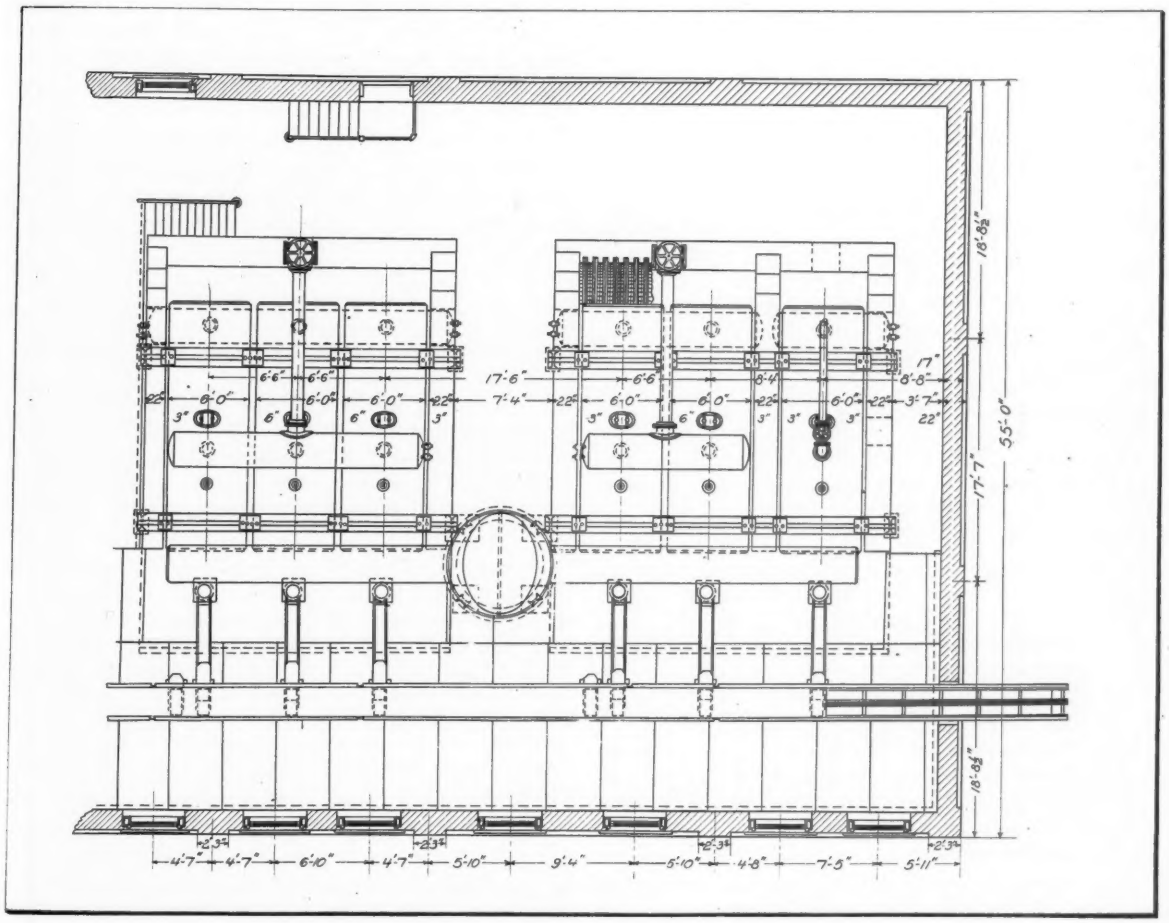


FIG. 2. PLAN OF BOILERS AND PIPING

THE BIG POWER PLANT of the Phoenix Water and Power Co., at Black Rock Dam, near Phoenixville, Pa., is being fitted with machinery to furnish power for the Schuylkill Traction Co.

PRACTICAL ENGINEER

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Lubrication as an Aid in Handling Peaks

The importance of adequate and suitable lubrication is becoming more generally understood each day and the improvements along this line are gratifying to both the operator and the owner of the power house. One effect of proper lubrication, however, an effect that if generally realized would do more than any other agency to bring about universal abandonment of the still common insufficient and uneconomical lubrication systems, seems not to be generally recognized; namely, the value of lubrication as an aid in handling and in efficiently tiding over peak loads. A smoking journal as a result of a heavy power load is not at all uncommon and, though the offending bearing may be quickly flooded with oil or other lubricant, the friction load has been seriously increased and a small peak thrown on the line at a time when it can least be afforded, for a journal will not smoke until after its friction has been unduly increased for an appreciable period.

Journal friction may be considered as composed of 2 constituents, dry, or solid, friction and liquid friction. Dry friction varies directly as the pressure, or load, on the bearing; liquid friction is independent of the pressure, or load on the bearing, and varies directly as the wetted surface for any given speed. The friction coefficient of a poorly lubricated journal is frequently 50 times as great as the coefficient of one properly lubricated, such difference in frictional loss taking place before the journal visibly smokes. The effect of a poorly lubricated bearing is exactly the same, then, as an increase in power load, or peak, while a properly and adequately lubricated bearing shows no increase in friction loss, whatever the load on the bearing, the wetted surface remaining the same under all loads.

Peaks are universally recognized as difficult to handle, so it would seem inexcusable to create an unnecessary peak—particularly at a time when the plant is already struggling against an unavoidable load peak—through the simple lack of a little lubricant. A lubricant is comparatively inexpensive, while failure to meet and tide over a peak load may be very costly.

Off Duty

And we talk about "high-pressure" boilers at a piking little 250 or 300 lb. per sq. in., and think of 600 lb. in a gas cylinder as terrific. Then the army man comes along with 30,000 lb. in his little 18-in. cannon and we give up and admit that our steam pressures are a joke as far as real man-size pressure is concerned. And now comes a Professor person, just a man with " 'satiable curiosity" such as got the elephant's child into trouble, and tells us of fussing with 300,000 lb. to the sq. in., just for the fun of seeing what happens. Likely he didn't have it on many square inches; but will somebody who wants to figure kindly estimate the bore, stroke, piston speed, etc., for a 2000-hp. engine with that pressure of 300,000 lb., that Dr. Bridgeman of Harvard got, for an initial pressure? Afraid the dimensions will not look familiar. And what area safety-valve would you need on the boiler? And how high would the boiler go if it blew up? And—oh, pshaw! what's the use?

It was for this kind of thing that the elephant's child got his nose pulled out so long that he couldn't tell which end his tail was on, so it has kept him busy ever since figuring whether he's going ahead or backwards. Besides, higher CO_2 is more important than higher pressure just now, for the mercury boiler and turbine are coming along with high temperature and low pressure; and the last half inch of vacuum on the end of a steam turbine sets loose more power than a lot of pounds added to the initial pressure.

Still, if we could get 300,000 lb. pressure into an engine, wouldn't she hum?

Meeting of the N. E. L. A.

THIRTY-SEVENTH ANNUAL CONVENTION, JUNE 1-5, PHILADELPHIA, PA.

AT the annual convention of the National Electric Light Association, held at the Bellevue-Stratford Hotel in Philadelphia, June 1-5, the following officers selected by the nominating committee were elected: President, H. H. Stott, New York; first vice-president, E. W. Lloyd, Comonwealth Edison Co., Chicago; second vice-president, H. A. Wagner, Consolidated Gas, Electric Light and Power Co., Baltimore, Md.; third vice-president, L. D. Gibbs, Edison Electric Illuminating Co., of Boston; fourth vice-president, J. S. Bleecker, Columbus, Ga., Power Co.; treasurer, W. F. Wells, Edison Electric Illuminating Co., of Brooklyn; executive committee to serve for 3 yr: Paul Spencer, United Gas Improvement Co., Philadelphia, Pa.; A. C. Einstein, Union Electric Light and Power Co., St. Louis, Mo., and Walter Neumiller, New York Edison Co.

The nominating committee recommended T. C. Martin as executive secretary.

Due to their close relationship to the power plant operator's work, a number of abstracts of the most important and interesting committee reports will be of value, the report on prime movers being of the greatest interest to the engineer.

PRIME MOVERS

IN THE average central station, means must be provided to have the boilers and furnaces in readiness to pick up the load as the nightly peak approaches, or to take the place of some disabled unit within a minimum space of time. The use of oil fuel for this purpose has been advocated by some, and at the Ashley Street power house, St. Louis, extensive experiments were made on getting the boilers under way by the employment of oil-burning apparatus; but it was found that the cheapest and quickest way to accomplish this is to use the oil for starting the fire on the chain grate. This is done by covering the grate with a bed of selected coal through which are run several strips of rags and upon which is placed a covering of wood kindling. The whole fuel bed is then soaked with oil.

When ignited, this bed of fuel is almost instantly a full grate of fire, and in a few minutes fresh coal can be added to the furnace.

Boilers are kept warm by means of hot water at a temperature of 200 deg., supplied by a hot water circulating system similar to that employed for domestic heating, a large tank with steam coil being installed below the boilers, the water circulating through the boiler, and the coil receiving hot water and steam at boiler pressure from the high-pressure drip system.

By this method, it is claimed the boilers can be placed in service within 15 min. time and the fuel cost for keeping the boilers in readiness amounts to the utilization of only 12½ lb. of coal per hour per boiler.

If the water in the boilers is not kept hot, as above stated, they can be brought into service within 15 min. by holding the fires in readiness.

FORCED DRAFT FOR PEAK WORK

THE ARTICLE on this subject is well worthy of consideration for existing stations where the boilers are subjected to extraordinary and unexpected demands for power or where they are overloaded.

If the forced draft is not for regular service, but is used only to force the boilers at time of peak load, the cost of the equipment is of greater moment than its operating efficiency; therefore, the installation that will produce the desired boiler capacity with the lowest initial outlay should be the one selected, which would mean the installation of steam blowers rather than power-driven fans.

In a particular installation, it was estimated that there were possibilities of making a saving by this means of about 3 per cent in the annual coal bill; but as it would be possible to decrease the number of boilers by 25 per cent, it appears that if we assume $40 per kw. as the cost of this part of the installation, a saving of 25 per cent will mean $10 per kw. saving on the cost of the entire plant; and taking the fixed charges at 14 per cent, there is an apparent annual saving of $1.40 a year per kw. of capacity; or, with an annual load factor of 40 per cent, this saving would be 0.04 cent per kw.-hr. If the operating costs of the station are taken at 0.3 cent, this 0.04 cent would be equal to 13 per cent of that amount, to which may also be added the 3 per cent saving in operating costs previously mentioned, making a total saving of 16 per cent of the operating costs by designing a station for the use of such blowers for peak work.

THE SMOKE AND CINDER PROBLEM

WHEN LOCATED in business or residential districts, power plant owners have frequently been brought face to face with legal prosecutions on account of the annoyance occasioned to the neighbors by the emission of smoke and cinders from the stacks.

When forced draft, with its greater or less pressure, is maintained in the ash pit, there is frequently a noticeable shower of cinders in the vicinity of the plant, especially when a coking coal is used.

In order to combat this nuisance, the New York Edison Co. has given much time to study and experi-

mentation, and in the opinion of the company's engineers, the problem was finally solved by causing the gas to impinge against a wet baffle plate, from which it is deflected downward toward a trough of water, in which the cinders are caught.

Electrical Apparatus

The report of the committee on electrical apparatus points to the increase in capacity of individual generating and converting units as has been marked by the development of generators of 35,000 k.v.a., 25 and 60-cycle rotary converters of 4000 and 2500 kw. respectively, rotary condensers of 15,000 k.v.a., frequency changers of 10,000 k.v.a., and other apparatus in proportion.

Improvements in efficiency have kept pace with increases in capacity of individual units, and although much of this increase in efficiency has been directly the result of the adoption of higher rotative speeds, the limits of safety do not appear to have been exceeded.

The success attending the initial operation of a number of high voltage transmission systems indicates that, as far as the reliability of station equipment and line construction is concerned, operating voltages as high as 150,000 volts may now be considered as commercially feasible.

The increasing tendency toward outdoor substations has been noted, and with further experience in their operation, entirely reliable results may be looked for from their use in all branches of the business.

Meters

The major portion of this section relates to legislative questions affecting metering, which have arisen throughout the country during the year.

The Committee on Meters has received numerous complaints of the breaking down of the insulation of the induction type meter in the potential or current circuits during the summer season when lightning storms are prevalent.

Tests conducted on the type of meter, referred to above, have, up to the present, not been sufficiently severe, and it is suggested that the following method be employed.

The ordinary 110 or 220-volt a.c. circuit is used as a source for testing current. This circuit is protected by fuses of proper size and controlled by a suitable switch. An auto-transformer is connected in circuit for regulation purposes to obtain the exact voltage desired, which will be indicated by the voltmeter. A pilot lamp is used as a safety precaution and shows when the current is on. The low tension secondary current is then stepped up by an inverted transformer of 20 to 1 ratio for 2000-volt tests, transformers of other ratios being used when a higher testing voltage is desired.

One side of the high-tension circuit is connected to all the various current and potential windings. The control switch is then closed and the other high tension lead is applied to the meter base for 30 sec. If no flash occurs, the meter has withstood the break-down test between coils and frame.

High Tension Transmission Design

In this paper, Selby Haar brings out the facts that the longest high tension transmission line is about 240 mi., and that, in most cases, the generating station is at one end of the line and the load practically at the other, although the desirability of carrying lines by different routes as a precaution against interruption of service is not being overlooked. The normal span ranges from 450 to 850 ft., the average being somewhat over 600 ft. Copper predominates as a conductor, no aluminum being used except on the American Continent, and for the lower voltages abroad. The vertical arrangement of conductors is in favor at present, but with the middle wire moved a short distance out of the plane of the other two. Very little importance is attached to the spacing of conductors or number of insulators, as so much depends upon climatic conditions and the topography of the region traversed by the lines.

Cost of Steam Making

Commenting upon this question at the meeting of the Ohio Society of Mechanical, Steam and Electrical Engineers, A. C. Rogers, of Toledo, called attention to a figure of 10 cents per 1000 lb., given by F. W. Ballard in a paper on District Heating by Live Steam, presented at a previous meeting, as being misleading. Although steam is furnished from one of the Cleveland municipal pumping stations through a line some 8000 ft. long at a price of 20 to 30 cents per 1000 lb., as shown by condensation meter on the customer's premises, Mr. Rogers was doubtful whether it was done without a loss, inasmuch as it is found to require economical operation to produce 1000 lb. of steam at the boiler header in most plants for 25 cents, allowing nothing for losses in transmission and cost of upkeep of distributing mains.

In a letter recently received by the editor of The Valve World, the writer—with what seriousness the reader is permitted to guess—pointed out that in all efforts thus far made to increase the efficiency and economy of the reciprocating steam engine, he had not seen it advanced from any quarter that ultimate and perfect economy might be secured by having the engine exhaust back into the cylinder. Exhaust steam has always been considered as so much waste, even when sent into a condenser. Utilizing the exhaust to keep the engine running seems feasible. Of course it would be necessary to have a cut-out either to the air or to a condenser until the engine should get properly "het up" and speeded; then the exhaust could be put to work to run the engine the remainder of the day. Meantime the fire under the boiler could be banked or drawn and the fireman could go to the ball game, and—talk about the unleashed fancy of the poet! How halting and crippled it is when entered in the lists with that of the inventor!

Recent records from flow meters attached to boilers in various plants show that the steam flow from a boiler varies temporarily inversely as the feed pump speed, provided there is call for the steam. This is because, with the fire in a given condition, the more water fed in, the greater is the amount of heat used in raising water temperature. When the pump slows down, more heat is available for evaporating water.

Power Apparatus in Shop and Market

New Ideas In Making, Buying and Selling

New Separator and Relief Valves in Fisk Street Station

THE steam separator illustrated in Fig. 1, is installed on the 17-in. header leading into unit No. 11, in the final extension at Fisk Street Station of the Commonwealth Edison Co., Chicago.

This turbine was built by Parsons & Co., of New Castle, England; is horizontal, of the Parsons type, and has the largest capacity of any turbine yet built, namely 25,000 kw. Being supplied with steam at 200 lb. pressure with 200 deg. of superheat, the application of a separator may at first appear strange. But practice has proven that water sometimes does exist in the presence of superheat; consequently, to avoid any possible damage to the rotor buckets, from a slug of water, a separator was deemed necessary. It consists of 4 principal sections—an inlet ell and outlet tee, and 2 body sections. An idea of its size will be gleaned from the dimensions shown.

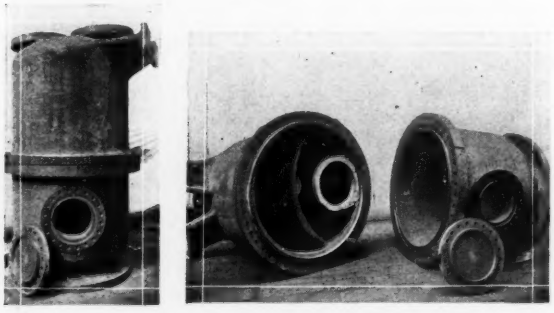


FIG. 1. ASSEMBLED VIEW AND PARTS OF THE EDWARD STEAM SEPARATOR

As a further precaution against any foreign substance passing through, a strainer is provided, which consists of a piece of extra heavy steel pipe, end piece welded in, and the entire strainer drilled as shown in detail. The shell is of cast steel thoroughly annealed and of high tensile strength. The bolts in the body, or 48-in. joint, are of vanadium steel, having a tensile strength of 100,000 lb., elastic limit 60,000 lb. It was tested for 1 hr. with a hydrostatic pressure of 1000 lb. per sq. in., and then for 1 hr. with steam pressure of 225 lb., and was required to remain tight. All flanges, except inlet and outlet, are supplied with the Edward double tight gasketless joint, as illustrated in the detail. The separator was designed by Sargent & Lundy.

The 40-in. differential relief valve here illustrated, was specially designed and built by the Edward Manufacturing Co., for the Fisk Street Station, 2 being required for the 2 25,000-kw. turbines just installed. It will be noted from the photograph showing the 2 valves

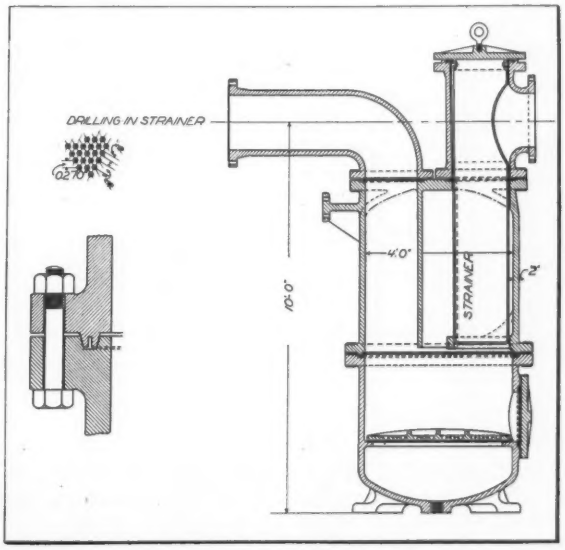


FIG. 2. SECTIONAL VIEW AND DETAILS OF THE EDWARD SEPARATOR

(the valves are standing upside down), that the lower cylinder is missing from one, which is due to the fact that this valve was placed after the condenser, or entirely on the vacuum, and therefore used as a simple

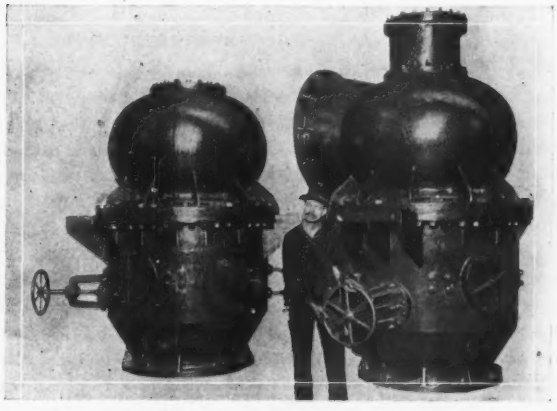


FIG. 3. RELIEF VALVES RECENTLY INSTALLED IN THE FISK STREET STATION

relief valve. The other valve is placed on the receiver between the high and low-pressure sides of the turbines. The tap at the extreme bottom under the piston, H,

leads to the condenser. The differential feature enters in that the valve is controlled by the combination of vacuum and receiver pressures, the areas being so proportioned that the valve opens if the receiver pressure rises above (in this case) 10 lb., or the vacuum drops considerably or is lost. The upper or inside piston acts

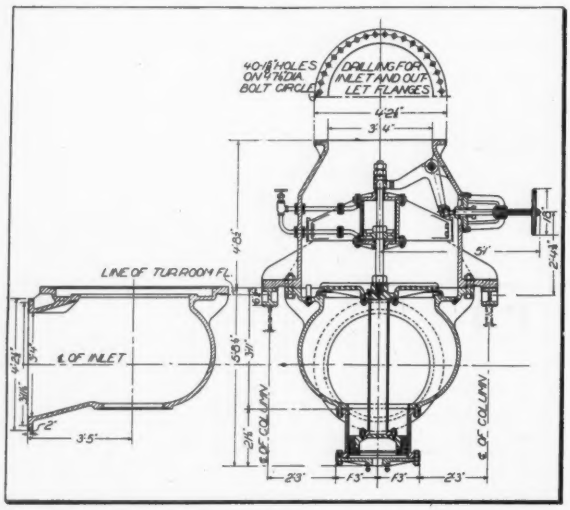


FIG. 4. SECTIONAL VIEW OF EDWARD DIFFERENTIAL RELIEF VALVE

both as a guide, and as a cushion to prevent the valve opening suddenly with a pound; this is effected by adjusting the small angle valve on the bypass, thereby checking the passage of the air on one side of the piston to the other side.

Oil Engine-Driven Air Compressor

INCREASED use of low grade oil fuel for power purposes has led to the design, by the Ingersoll-Rand Co., of the oil engine driven air compressor illustrated herewith.

This is of the direct-connected straight line type and somewhat resembles in this respect, as well as in the design of the air end, the company's standard line of small compressors. The main frame is designed for a splash system of lubrication; it is of the wholly enclosed type and provided with removable covers.

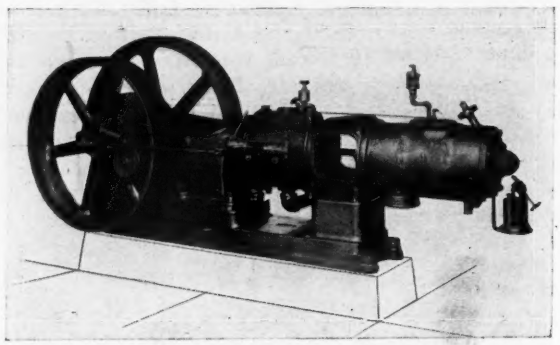
In this machine, the feature of greatest interest is the design of the driving end. This, as can be seen from the illustration, consists of a single oil engine cylinder set behind the air cylinder and directly connected, by means of an extended piston rod, to the air piston. It follows in general design, a type known as the hot bulb engine, which is really a development of the Diesel engine, and combines a high thermal efficiency with simplicity of construction, making it an ideal type for compressed air service.

The power cylinder is of the single-acting, 2-cycle type. It is water-jacketed and provided with an efficient system of lubrication and is of sturdy design; it is supported by a heavy distance piece, reaching to the foundation and bolted to the air cylinder. It is fitted with a torch for heating the ignition bulb preliminary to starting. After the compressor is under way this torch is dispensed with.

Fuel is automatically injected into the combustion chamber by means of a small pump on the side of the frame, operated by the main shaft. It enters in the form of a finely atomized spray and is immediately ignited by the hot bulb, dispensing entirely with electric sparking devices, batteries, etc. The stroke of the fuel pump is regulated by a centrifugal governor located in the flywheel, thus regulating the amount of fuel injected into the cylinder in proportion to the load. This is supplemented by a regulating device, on the intake to the air cylinder of standard design.

Pure air is used during the scavenging period of the stroke, consequently the inlet and outlet ports can be so arranged that thorough scavenging is afforded without any loss of fuel.

A feature of this engine is the introduction of a small quantity of the water from the cylinder jacket, into the combustion space. The water performs the function of regulating the temperature in the cylinder, thereby preventing an undue rise in temperature of the piston, etc., causing disassociation of the fuel. It reduces the maximum pressure in the cylinder, at the same



NEW TYPE OF AIR COMPRESSOR UNIT WITH OIL ENGINE DRIVE

time slightly increasing the mean effective pressure, making a smooth running and highly economical machine. The amount of water injected is regulated according to the load on the compressor.

The whole machine is compact and self contained; it is, at present, made in but one size with an actual capacity, when running at 325 r.p.m., of 66 cu. ft. of free air at 100 lb. pressure and 73 cu. ft. at 80 lb. pressure. The fuel consumption at this speed, and under average operating conditions, is about 2.2 gal. of kerosene an hour. It is adapted to run on either kerosene, fuel oil or distillate. Its weight complete is 3000 lb., and floor space 8 ft. 10 in. by 2 ft. 5 in.

TWO GOOD SAFETY rules for the power plant are: No construction or repair job is considered finished until it is made as safe as possible for operators. Do not meddle with things you do not understand.

Nonpareil Insulating Brick

THESE bricks are not made of a refractory material and cannot be used as a substitute for fire brick, but are intended for use only as an insulation to back up fire brick where the retention of heat is desirable.

Diatomaceous earth (known also as "kieselguhr" and infusorial earth), a small amount of clay and finely ground cork make up the mixture, which is molded while wet, into 9 by 4 by 2½-in. brick. These are dried and then fired, the cork being first carbonized and afterwards gradually burned out completely, so that the brick is subjected to uniform heat throughout. After the cork is burned out, the brick, which is of a light terra cotta color, is left porous in texture and weighs about 1½ lb.

The heat conductivity of Nonpareil brick is approximately 12 B.t.u. per sq. ft. per degree difference in temperature per inch of thickness per 24 hr., as compared to 120 B.t.u. for fire brick, so that the insulating effect of a single course of Nonpareil brick 4 in. thick is equivalent to that of 40 in. of ordinary brick. Compared with other forms of insulation, designed for a similar purpose, this material will withstand relatively high temperature, since it is composed of practically pure silica, the fusing point of which is about 1600 deg. F. Although weighing but 29 lb. per cu. ft., this material has a crushing strength of 140 lb. per sq. in.

For laying the brick, a special cement is used of practically the same composition as the brick, thus forming a solid, unbroken wall of insulation. A thin mortar is made by mixing the cement with water, and should be applied with a trowel, care being taken to fill all joints completely. Before being put in place, the brick should be dipped in water, and then laid in a full bed of the mortar, approximately ¼ in. thick. Four hundred pounds of this cement are supplied with every 1000 bricks.

Nonpareil insulating bricks are manufactured by the Armstrong Cork Co., Pittsburgh, Pa.

Temperature Regulators

POWER for actuating these devices is furnished by the expansion of a sensitive liquid hermetically sealed within a chamber containing a flexible corrugated tube. These instruments may be used for the regulation of room temperatures, tank temperatures and mixing valves, the principle of operation being the same for all cases.

As shown in Fig. 1, these regulators consist of 3 principal parts, the thermostatic element, which is inserted wherever the temperature is to be regulated, the controller element, and the valve. The thermostatic element of the room temperature regulator, Fig. 1, is mounted on a board exposed to the atmosphere. The tubular receptacle contains a heavy hydrocarbon oil into which is inserted a piece of corrugated copper tubing, the length of which may be varied by turning the screw at the upper end. From this vessel a piece of fine copper tubing passes to the controller, which also contains a piece of corrugated tubing, whose length diminishes when an increase of temperature causes the oil to expand. When the temperature of the oil rises, the pressure increases and is transmitted to the controller element, resulting in a compression of this corrugated tube, which forces out the piston and tends to close the valve. Spiral springs—one above the valve and the other at the top of the controller—oppose this action, tending to keep the valve open.

This regulator is applicable in places where the temperature of the atmosphere must be kept uniform, such as office buildings, living apartments, drying rooms, etc. Where natural gas is used, it may be applied in conjunction with various burners to regulate the flow of gas and maintain even temperature. The action of the regulator is positive, and its reliability makes it suitable for delicate manufacturing processes, as well as for ordinary room temperature regulation.

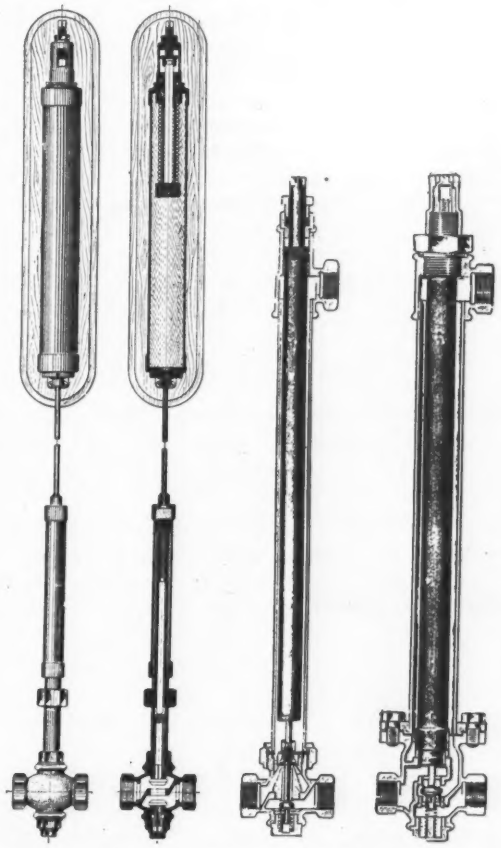


FIG. 1. EXTERIOR AND INTERIOR OF ROOM TEMPERATURE REGULATOR, SHOWING CONSTRUCTION AND PRINCIPLE OF OPERATION

FIG. 2. MIXING VALVE FOR LOW-PRESSURE STEAM

FIG. 3. MIXING VALVE FOR EITHER HIGH OR LOW-PRESSURE STEAM

A similar regulator is made for tank temperatures. It is easily installed and can be arranged to regulate the temperature of water or any other liquid, operating ordinarily at from 86 to 212 deg. F., or at lower and higher temperatures, if desired.

Mixing valves, shown in Figs. 2 and 3 are constructed so that hot water or steam is supplied at one side and

cold water at the other, permitting the continuous discharge of water at a constant temperature. In the interior of the valve is a mixing chamber containing an expanding cartridge which controls the size of the hot water or steam inlet. Under ordinary conditions, the discharge water is maintained at a temperature which will not vary 1 deg. F.

This valve is made in 2 forms, 1 for low pressure and the other for either high or low pressure steam. The low-pressure type, Fig. 2, has a range of temperature of the discharge water up to 159 deg. F., while the high-pressure type, which is double seated, has a safety tube and can be arranged for discharging water with a temperature of 80 to 212 deg. F. The mixing valve is adapted for use wherever a supply of water at constant temperature is required in manufacturing operations or in hospitals for therapeutic purposes.

These compact, simple temperature regulators are easily installed and are provided with an adjustable regulating device by means of which any desired temperature within given limits can be maintained constantly. They are manufactured by the Sarco Engineering Co., of New York, N. Y.

Ohio J. D. Valves

THIS is a new line, manufactured by the Ohio Brass Co., of Mansfield, O., in 2 styles; the standard pattern, for 150 lb. working steam pressure, and the special pattern, for 125 lb. pressure, the only difference being that the special pattern is a trifle lighter in weight.

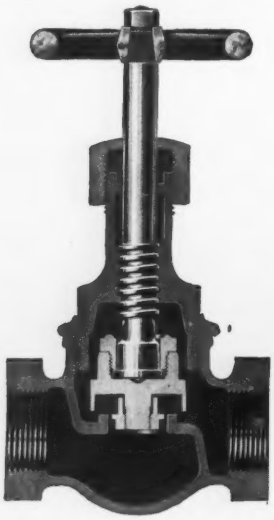


FIG. 1. STANDARD PATTERN, FOR 150 LB. WORKING STEAM PRESSURE

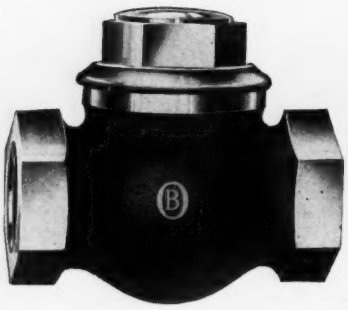


FIG. 2. HORIZONTAL CHECK VALVE

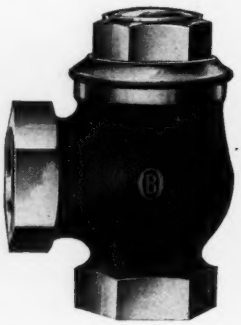


FIG. 3. ANGLE CHECK VALVE

FIG. 4. VERTICAL CHECK VALVE

Figure 1 shows the standard pattern in section, and illustrates the construction of the valve, with the composition disc, which has been tested out as suitable for the most exacting and lasting service, and which is reversible and renewable, with the packing cap on the bonnet, which comes filled with packing when the valve is shipped, and can be repacked under full pressure if the valve is opened wide, so that the top of the disc holder bears against the under-surface of the bonnet.

As usually shipped, discs are provided for 150 lb. working steam pressure, in both the standard and the special pattern; but, if so ordered, discs will be provided suitable for cold water, air, gas, or other special service. The valves are made up in straight or angle form, with right-hand screwed ends, for both inlet and outlet, and in sizes from ⅛ in. to 3 in.

In check valve form, they are made for horizontal, angle, or vertical locations, as illustrated herewith, with screwed ends, and in the same sizes as the stop valves.

The Shaw Wrench

HEREWITH is illustrated an interesting device, the Shaw wrench, which automatically grips any size or shape of nut, rod, or bolt up to its capacity, without adjustment, and has no pieces to come loose. The illustration shows the principle. When the wrench is placed against the pipe and the handle pulled, the

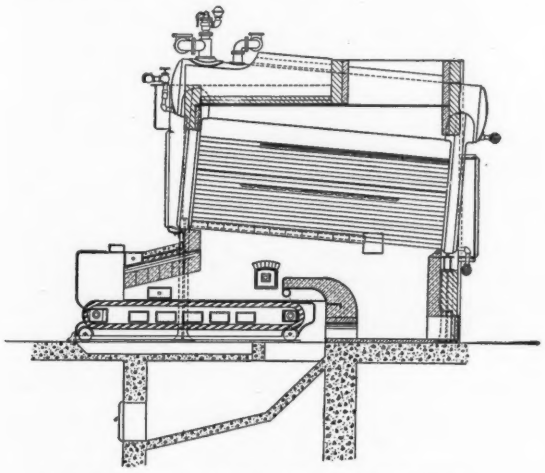
SHAW SPRING WRENCH

slot in the main stem springs together, permitting the toothed upper jaw to grip on the pipe or rod, and the harder the wrench is pulled, the tighter will it grip. The action is the same as that of an alligator wrench, only that it has a spring grip instead of solid. As soon as the pull is released, the spring automatically loosens up on the pipe and releases the wrench.

It is made of a thin stock, so that it will go into close quarters, and takes hold as soon as the pull begins, so that it can be used with one hand. It is made by the Shaw Propeller Co., of Boston, Mass., in 8, 10, and 15-in. sizes, the 8-in. being suitable for pipe from ⅛ to ⅞ in. in diameter, the 10-in. from ¼ to 1½ in.

Divided Pass Baffle for Heine Boilers

THIS baffling as used in 3 Heine water-tube boilers of 540 hp. each, set over McKenzie chain grate stokers in the Lytton Building, Chicago, is shown by the sectional view herewith. The boilers are of the high-pressure type, built in accordance with Chicago requirements for 200 lb. working pressure. Each boiler has 2 large shells built of 3 sheets ½ in. in thickness with the longitudinal seams of the triple-riveted, double-strap, butt-joint type, and the round-about seams with lapped joints, single-riveted. The water legs are built of 2 sheets, machine flanged and joined by a butt strap along the bottom and sides, and are double stayed, that is, are built with twice the customary number of hollow staybolts. Each boiler has 349 3½-in. by 16-ft. hot finished seamless tubes of No. 9 gage.



SECTIONAL ELEVATION AND BOILER SETTING

The drawing shows the setting of one boiler, also the baffling. Each boiler is supported on a steel chair at the rear and cast steel brackets riveted to the sides of the front water legs rest upon column supports. Boilers at the rear permit of free expansion and contraction.

The lowest rows of tubes is encircled by "L" tiles to within about 5 ft. of the rear water leg. This row of tiling serves as a roof for the furnace and combustion chamber and permits of a simple and standard arrangement of the stoker, with plenty of room to give the flames time to burn out without an excessively high setting. The flame travels horizontally and the gases burn out in the combustion chamber, before reaching the tubes.

The middle baffle rests upon the ninth row of tubes with an opening both front and rear. The top baffle extends from the rear water leg to within several feet of the front water leg, leaving an opening for the discharge of the gases from the boiler tubes. The gases entering the boiler divide into 2 streams, one flowing beneath and the other above the middle baffle. Before passing to the smoke outlet, the gases flow under the boiler drums.

New Bristol Electric Tachometer

THE field of usefulness for recording tachometers includes use in connection with all engines, machinery or revolving shafts, wherever information is desired about the rate of speed at which shafting or any other devices are revolving. Recording tachometers are usually required for continuous service under ordinary shop or mill conditions, and for this reason must be made rugged and durable to be thoroughly successful.

A new Bristol's electric tachometer of the a.c. type, which is particularly well suited to rough operating conditions in mills, power plants, or shops, is being put on the market by The Bristol Co., Waterbury, Conn.

Two of the most important features of this tachometer, which makes it particularly strong and durable, are the induction magneto and the voltmeter movement. The magneto, as shown in the accompanying illustration, is of the induction type, without any sliding con-

COMBINATION INDICATING AND RECORDING BRISTOL ELECTRIC TACHOMETER

tacts or brushes. The indicating and recording instruments are voltmeters. The indicating instrument is equipped with a Weston pivot jewel bearing voltmeter movement. The recording instrument is equipped with an improved Bristol voltmeter movement so designed that there is plenty of power available for actuating the recording arm, even though the recording pen is in continuous contact with the surface of the chart. In this recorder the movement is mounted on frictionless knife edge bearings. This movement is equipped with a new patented supporting device for the moving elements designed to eliminate temperature error. This recorder can be furnished for use with either 12, 8, or 6-in. charts.

The accompanying illustration shows a combination indicating and recording unit, which provides an indicating instrument for the operator and a recording instrument for the superintendent or foreman in his office.

UNIVERSAL CRAFTSMAN COUNCIL of Engineers will hold its Annual Convention at Cleveland, O., Aug. 4-7, W. H. Kennedy being chairman of the convention committee.

Arc Welding

THE subject of arc welding is receiving a great deal of consideration at the present time by railways and industrial concerns because of the many advantages it possesses for certain kinds of work.

Arc welding is particularly adapted to various uses in machine shops and foundries. Worn parts of machines can be built up prior to machining. Broken parts of steel castings can be welded together. Often defects develop in new castings, after considerable

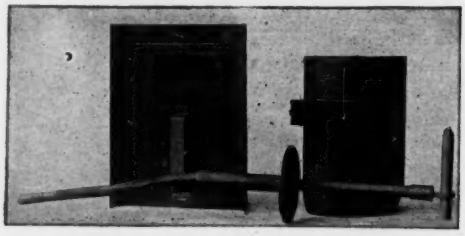


FIG. 1. SHIELD, HOOD AND CARBON HOLDER

machining has been done. The machining and castings, in many cases, can be saved by repairing with the electric arc. Castings with blow-holes and sand holes can often be quickly repaired. Risers and sinkheads can be cut off.

Realizing from past experience, the practical value of the electric arc for general welding purposes, the Westinghouse Electric & Manufacturing Co. has developed a standard line of electric arc welding equipments.

The equipments comprise standard apparatus. They are simple in construction and easy to operate. Complicated relay schemes for automatically inserting re-

FIG. 2. FILLING A MUD RING

sistances are eliminated. Ample protection is secured by circuit breakers and special arrangement of the resistance.

The outfits are furnished complete in the 4 following sizes: 200, 300, 500 and 800 amp. Each equipment includes a welding generator, or a welding motor-generator set, switchboard, control and all necessary accessories. The welding generator consists of a special 75-volt, commutating pole, direct-current machine, either belt or motor-driven.

The instrument and control panels are composed of 2 sections. The upper section contains the indicating instruments, protective apparatus and switches arranged for regulating the welding current, and the lower section contains the starting and protective equipment for the motor-generator set. It is often desired to have several welding circuits connected to one generator. For this arrangement a control panel is provided for each circuit. Each panel can be located at the most desirable place. Metal or carbon pencil welding can be done from any of these panels, independent of all others, and one or more arcs can be operated simultaneously.

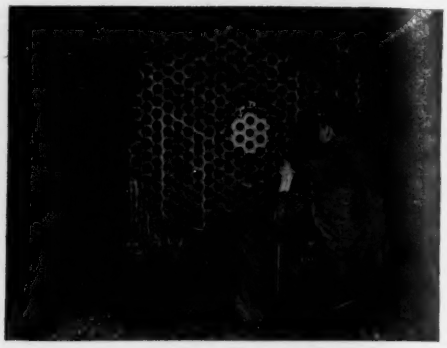


FIG. 3. ARC WELD ON BACK FLUE SHEET OF STEAM LOCOMOTIVE

Accessories furnished consist of a carbon holder and a hood for protecting the operator, together with a shield and a metal pencil holder for each welding circuit.

The equipment described above is the result of 8 years' experience in its own shops by the Westinghouse Electric & Mfg. Co., and has been employed on all classes of commercial work, thus ensuring a thoroughly practical shop outfit.

WHERE THERE is trouble with deposits forming in the water jackets of combustion engines, the difficulty is usually to be found either from foreign matter in solution, which is deposited on the surfaces, or from mineral salts which are held in solution at low temperatures, but which are precipitated as the water is heated. In such cases, if the water is continuously recirculated, much of the difficulty may be overcome by filtering and treating the water before it is put into the jacket and cooling tank, and then taking the water from the top of the heating tank. The foreign matter and precipitate will largely settle to the bottom, so that clear, soft water will be taken off for use in the cooling tank.

Where this is not possible, if a rapid circulation can be produced, so that the outlet temperature can be kept below 140 deg. F., there will be comparatively little tendency for the matter in solution to be thrown down, and if this circulation is kept up for a short time after the engine is shut down, precipitation in the jackets will be largely avoided. After the deposits are formed, the best way to remove them is by the introduction of a strong solution of soda ash, which will dissolve and loosen the scale deposit, and the jackets can then be washed out with a strong current of clear, cool water, which will remove the sediment and loosen the scale.

Hopkins Electric Tachometer

INDICATES SPEED AT ANY DISTANCE FROM REVOLVING SHAFT. FOR PERMANENT INSTALLATION OR PORTABLE USE

THIS INSTRUMENT consists of a small, direct-current magneto generator and an indicating voltmeter, the 2 parts being connected by a 2-wire insulated cable. Since the voltage generated by a system of coils rotated within a permanent magnetic field is in direct proportion to the speed of rotation, it is possible to calibrate the voltmeter in terms of speed for revolutions per minute.

An indicating instrument of the D'Arsonval or permanent field type is used, consisting of a permanent horseshoe magnet between whose poles swings, in an arc of 90 deg., a light moving system. This moving coil is supported by 2 large and ruggedly constructed sapphire bearings and is mounted upon an aluminum frame.

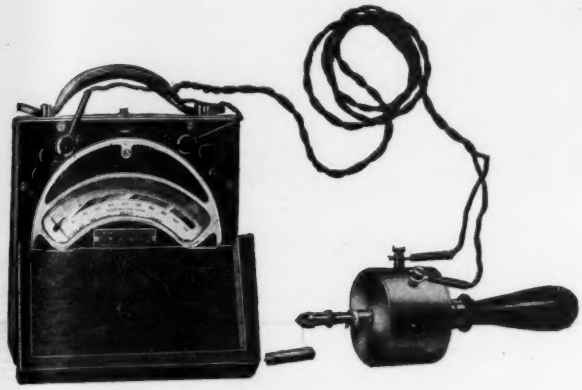


FIG. 1. PORTABLE TYPE OF ELECTRIC TACHOMETER

The moving system responds to minute voltages throughout the entire range and also gives an angular deflection directly proportional to the electrical pressure applied, which permits the use of an evenly divide scale. Since there is practically no wear resulting in lost motion, and as the accuracy of the system is not affected by temperature changes, steady readings may be obtained at all speeds. Figures 1 and 2 illustrate the portable and switchboard types of instrument.

The magneto used is of the direct-current type and consists of a 6-pole armature rotating between the poles of a permanent horseshoe magnet. The current generated in the armature is sent to the line through a commutator of 6 parts, the rotating bars and brushes being of gold, platinum or sterling silver. On account of the high grade material used in brushes and commutator bars, no variation in the resistance of the circuit occurs.

By means of carefully made spur gears the magneto armature is driven from the main shaft. The bearings of the armature and the commutator are enclosed entirely within the water-tight and dust-proof case, where grit cannot grind them away. This construction allows of a very small air gap between the magnet limbs, thus insuring permanence of the thoroughly aged magnet.

By the use of internal reduction gears, high speeds can be measured with precision, without exceeding the practical limits of commutation. With this arrangement, wear on the main bearings will not affect the clearance between the armature and pole pieces, nor will end play of the main driving shaft give trouble with the brushes on the commutator. The internal gears furnish an elastic drive, and any chatter set up in the main driving shaft is not communicated to the armature and commutator shaft, therefore allowing of a steady reading tachometer.

FIG. 2. SWITCHBOARD MODEL WITH SPLIT GEAR FOR SHAFT

The Hopkins electric tachometer is manufactured in various sizes and models by the Electric Tachometer Co., of Philadelphia, Pa. It also supplies graphic recording instruments and capacity indicators with scale readings in output per hour.

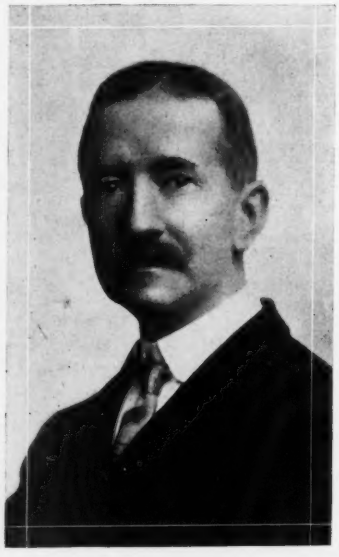
MANY OF THE GREAT PAINTINGS of the old masters, which have never before been loaned to any exposition, will be seen in the Palace of Fine Arts at the Panama-Pacific International Exposition. These have been secured through the efforts and enthusiasm of John E. D. Trask, Chief of the Department of Fine Arts, who has just returned to the United States after a tour of Europe, where he enlisted the interest of all the art centers in the exposition's plan for a wonderful display of art. In all he secured promises of 350 of the priceless masterpieces.

News Notes

E. W. ALDERMAN, an experienced refrigerating engineer who, for a good many years, has been connected with the Vilter Manufacturing Co., has been appointed manager of the Pittsburgh District and will have his headquarters at 314 Curry Building, Pittsburgh, Pa. He succeeds H. W. Loecher, who has been transferred and will be located at the Main Offices in Milwaukee.

THE AMERICAN PETROLEUM SOCIETY has been formed, through the efforts of various oil associations, and those interested in government work along this line, the objects being to accomplish standardization of tests of petroleum and petroleum products, and of the apparatus for making such tests, and also to bring together fundamental general knowledge on petroleum, so that it can be used by those interested; and to encourage study and research as to methods of producing, refining, marketing, and using petroleum, its products and natural gas.

THE BOARD OF DIRECTORS of The Westinghouse Machine Co. has elected Wm. A. Bole to be "Vice President in charge of Production and Erection" for the plants at East Pittsburgh and at Trafford.



Mr. Bole has been in the continuous employ of the company since August, 1882, having successively filled the position of general shop foreman, superintendent, manager of works and consulting engineer, and has therefore taken part in the growth and development of the company since it employed less than 100 men, until the present, when the total forces run up into the thousands of operatives.

AN EXHIBITION of power plant machinery, accessories and supplies will be held in Infantry Hall, Providence, R. I., July 8 to 11, in connection with the annual convention of the New England States Association of Stationary Engineers. The exhibit will be under the direction of the New England Association of Commercial Engineers, 53 Equitable Bldg., Boston, Mass., and full information in regard to spaces, prices and arrangements may be had by writing to that address.

CHARLES F. EIKER, treasurer of the Perolin Co. of America, while on a business trip to Cleveland, O., to meet Mr. Kopperl, the president of his company, was suddenly stricken, and died on June 6. He left Chicago apparently in perfect health, and was taken ill on arrival in Cleveland.

Mr. Eiker had been associated with Mr. Kopperl for many years in the development of the business. He was a man whose word was relied upon implicitly by those who knew him, and his kindly nature and devotion to business made him popular with friends and with his business associates.

TO INCREASE THE CAPACITY of the Brunot Island power plant to 100,000 hp., the Duquesne (Pa.) Light Co. has ordered new equipment, boilers and buildings for that plant. Steam turbines will be used in connection with electric generators, which will mean the abandonment of 3 5000-kw. turbo-generator sets that have been in use for some time. The street car lines within the city, the street lights and thousands of private motors will be operated from this plant, which will be carefully placed beyond the reach of floods.

The contracts for the turbines and generators call for an expenditure of $400,000, and for the boiler plant for an expenditure of $200,000. The Westinghouse Electric and Manufacturing Co. has the electrical order.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for assistant mining engineer, July 13, 1914. From the register of eligibles resulting from this examination, certification will be made to fill vacancies in this position in the Bureau of Mines, Department of the Interior, for service in the field, in relation to coal mining or metal mining, at salaries ranging from $1800 to $2400 a year. The duties of these positions will include, in one case, investigations in relation to coal mines, and in another case in relation to metal mines, particularly such as concern the causes of mine accidents of waste in mining, and the suggestion of remedies therefor. It is desired to procure the services of persons having a broad training in mining, particularly underground experince. Competitors will not be assembled, but will be rated on the following subjects, which will have the relative weights indicated: Education, 40; Professional experience, 40; Publications or manuscript reports, 20. An educational training equivalent to that required for graduation in mining engineering from a college or university of recognized standing, and not less than 3 years' experience as a mining engineer, mine foreman, or superintendent in coal mining or metal mining operations, or both, are prerequisites for consideration for this position. Applicants must have reached their 25th but not their 35th birthday. In applying for this examination, ask for Form 304, using the title, Assistant Mining Engineer, Male.

UNITED STATES CIVIL SERVICE COMMISSION announces an open competitive examination for structural engineer and draftsman, on July 8 and 9, 1914, to fill vacancies in the Office of the Supervising Architect, Washington, D. C., at entrance salaries ranging from $1600 to $1800 a year and vacancies in the position of first-class structural draftsman in the Panama Canal Service, at entrance salaries ranging from $150 to $175 a month. The

following subjects will have the relative weights indicated: Practical questions in engineering construction, 70; training and experience, 30. Applicants must have had not less than 5 years' practical experience, of which at least 2 yr. should be in either steel designing (not merely detailing) or construction work. A degree in civil engineering from a technical school of recognized standing will be considered as equivalent to not more than 2 of the 5 yr. A rating of at least 70 per cent in the subject of training and experience is a prerequisite for consideration. Age, 23 yr. or over on the date of the examination; but no competitor who has reached his forty-fifth birthday on the date of the examination will be certified for appointment to the Panama Canal Service. Each applicant for the Panamal Canal Service will be required to submit to the examiner, on the day he is examined, a photograph of himself taken within 2 yr., which will be filed with his examination papers. In applying for this examination, ask for Form 1312, using the title, Structural Engineer and Draftsman (Male).

Book Reviews

ELECTRIC MOTORS, THEIR ACTION, CONTROL AND APPLICATION, by Francis B. Crocker and Morton Arendt; second edition; 305 pages, with diagrams and full page plates; New York, 1914. Price, $2.50.

The present edition of this book is greatly improved over the first edition, which was placed on the market in the early part of 1910; many amendments and additions make the subject matter clearer and more complete. These changes apply to the illustrations and diagrams as well as the text, as, for example, on Starting Box Calculations for direct-current shunt and alternating-current induction motors, and an entire chapter on the power requirements of various tools, etc.

In this work the authors have well accomplished their object, which is to set forth the action and operation of the various types of electric motors with sufficient comprehensiveness for those who study or use these machines, including students and practitioners in electrical engineering. At the same time, particular care has been exercised in omitting matter that is of only theoretical or special interest. In other words, both the scope and the volume have been kept strictly within the limits of a hand-book, and no attempt has been made to produce an encyclopedia of the whole subject or an exhaustive treatment of a particular branch.

MECHANICAL LABORATORY METHODS OF TESTING MACHINES AND INSTRUMENTS. By Julian Smallworth, New York, 1914, 330 pages, full illustrated and indexed, 5 by 7 in. In flexible leather binding, price $2.50.

This book, by a man who has had much experience in the lines with which it deals, does not contain lengthy descriptions nor analysis of the action of all the instruments which are to be used in the test. It does, however, cover briefly the broad principles of experimental apparatus and methods, and shows how to carry out many tests which are of vital interest to the man who operates machinery.

The introduction deals with the classes of errors likely to be found in tests, the limitations of instruments, standards of measurement and rules for testing.

Following this is Part 1, on the testing of instruments, which takes up the calibration of gages, steam, draft and dead weight, determination of the constants of different forms of brakes and dynamometers, calibration of indicators, including the spring, the pencil motion, the motion of the drum, reducing motions and reducing wheels, testing of planimeters for correctness of measurement, and the calibration of apparatus for measuring the flow of liquids and gases, including weirs, Venturi meters, nozzles, Pitot tubes, orifices and special flow meters; the calibration of thermometers and of calorimeters, and the determination of constants for oil and belt testers.

Part 2, on the analysis of combustion, deals with the constituents of fuels, and with the determination of heat value of coal and other fuels, and with the principles of gas analysis.

Part 3, taking up the testing of power plant units, deals with valve setting, efficiency and economy tests for engines and the entire plant, tests of pumps and injectors, testing the steam boiler, economy and efficiency tests for internal combustion engines, testing of blowers and air compressors, tests of turbines, centrifugal pumps and other hydraulic machinery, and tests of lubricating oils.

A knowledge of algebra, trigonometry and the derivation of formulas is necessary to a complete understanding of the book, but much valuable information can be derived in regard to methods of making tests and analyzing results, even if such knowledge of mathematics is not available.

ENGINEERS' HANDBOOK OF TABLES, CHARTS AND DATA ON THE APPLICATION OF FANS AND FAN APPARATUS FOR HOT BLAST HEATERS AND SYSTEMS OF AIR DISTRIBUTION. By Willis H. Carrier. 570 pages with index and tables, 4 by 7 in. In flexible leather binding with round corners and gilt edges, price $3.

As stated in the preface, there has been no effort up to this time to collect, under one cover, complete and reliable engineering data concerning fans and their application to various industrial requirements, and this book is intended as a guide and an effort to standardize rules and data for use with any standard make of equipment. The greater part of the data is the result of tests and research made by the engineering staff of the Buffalo Forge Co., in the testing laboratories of that company, and these results in most cases have not heretofore been published, except in scattered papers before engineering societies. The book is carefully written, is full of valuable tables which make calculations simple and easy, and gives practical illustrations of how the different rules and formulas are to be applied. An idea of the subjects covered may be gained from the following:

Full data is given on the heat loss through building walls, roofs and floors, such as is needed either for computing heating plants or for calculating the loss in refrigeration houses. The amount of heat needed, and also the air to be supplied for ventilating different classes of buildings is given, also the methods used for washing, cooling and humidifying air and the properties of air in different degrees of saturation. Under the subject of mechanical draft the resistance of fuel beds of different thicknesses, and of the boiler passages for different rates of combustion are given, and the amount of air needed for supplying combustion at different rates is shown.

Proportioning and installation of exhausters for taking away dust and shavings are given, also for blowing systems, such as foundries, the friction in ducts, elbows and nozzles, and data in regard to ducts is given in the text and in tables.

Fan design is then taken up, showing the capacities of various types, the relations of speed, size and velocity, and methods of fan testing and the instruments used.

The performance of heaters treats of the velocity of air through the coils, the amount of surface needed in the coils, and the design of washers and humidifiers for ventilating systems. Tables are given for the horsepower of fan and blower engines at various pressures, sizes and speeds.

A section is devoted to the selection of apparatus for heating and ventilating with samples of satisfactory specifications for such apparatus, and at the end of the book a number of tables are incorporated, giving the capacity of chimneys for boiler horsepower, the loss in pressure of steam through pipes at different velocities and different pressures, and other data convenient in making calculations on heating, ventilating and draft systems. The material is valuable, carefully chosen, well presented, and the book is a distinct addition to the literature on fans, blowers and their uses.

AIR TANK REGULATIONS, as prescribed by the Board of Boiler Rules of Massachusetts, are incorporated in a 50-page booklet recently published, which prescribes how such tanks shall be tested, how the strength shall be determined, and the factor of safety allowable, provision for safety valves and their testing, strength and efficiency of riveted joints, staying to be used for flat surfaces, and reinforcement for openings to connect pipe and for manholes. Many of the rules are similar to those for steam boilers, but the subject is completely covered. Pamphlets may be obtained from the Board of Boiler Rules, State House, Boston, Mass.

HEAT. By E. M. Shealy, first edition, illustrated, 6 by 9, 262 pages. Price, $2.00. This text is designed to supply the fundamental knowledge necessary for the successful study and understanding of all heat-using machinery, such as the steam engine, the gas engine, the refrigerating machine and the air compressor. The book starts with an elementary consideration of the subject, giving definitions and descriptions of various pieces of apparatus used in the measurement of temperature, work and power. After the principles of heat, its transfer and measurement, generation and effects upon gases have been discussed, the properties of steam and other vapors are taken up in a complete chapter followed by another upon condensation and evaporation. The book closes with chapters upon steam engines, air compression, gas engines, refrigeration and house heating. It is written in a clear and concise manner and serves well its purpose as an elementary treatise on the subject of heat.

ARITHMETIC OF THE STEAM BOILER. By Charles J. Mason. New York, 1914; 5 by 7 in., 220 pages, indexed with tables of circumferences, areas, squares, cubes, square and cube roots, and the factors of evaporation. Cloth bound, price $1.

The book is a compilation of rules and formulas applicable to steam boilers of various types, gathered by the author during his career as a steam and marine engineer covering a period of 25 yr. The intent of the book is not to teach the elements of arithmetic but only their application to calculations regarding the steam boiler, so that the user may have these rules and formulas ready for use in compact and convenient form for reference.

The rules cover the strength and stress of the sphere and cylinder under pressure, riveted joints, boiler heads and the staying of flat surfaces, the use of diagonal and girder stays, reinforcing of manholes, the strength of furnaces, boiler efficiency and boiler trials, safety valves and feed pipe.

The book is well designed and well written for the purpose in view and the only criticism might be that it is rather brief on some important parts, as, for instance, the matter of riveted joints and of boiler stays; but the elementary principles of these important matters are clearly brought out.

Catalog Notes

LITTLE DAVID Riveting Hammers, Form 8011, and Rivet Set Retainer for Little David Hammers, Form 8011-1, are the subjects of 2 bulletins just issued by Ingersoll-Rand Co., 11 Broadway, New York City. All "Little David" riveting hammers can be furnished with a rivet set retainer, which is simple and unique in design and meets the requirements of the safety laws being drafted by the various states. Bulletins are illustrated to show application of the tools, and also give sectional views to show the details.

Form 4020, also issued by the company, is a 32-page catalog of Leyner Ingersoll Water Drills. Among the features of construction may be mentioned the "Hand Hammer Blow," "Water Feature," "Oiling System," "Butterfly Valve," "Sergeant Rotation," "Ireo Metal," etc., the catalog is illustrated and gives descriptive table of sizes and capacities.

Copies of these catalogs will be supplied free on request.

GENERAL ELECTRIC CO. has recently issued Bulletin No. 41,302, which covers the complete line of G-E Standard polyphase induction motors. The characteristics of the different forms of these motors are analytically described, and the windings used for various classes of service are shown. Illustrations show in detail the construction of the component parts of the motors, and the bulletin also illustrates and describes the various types of compensators and control apparatus required; it illustrates repair parts for the complete line, the illustrations being keyed by suitable letters to a list of parts; repair parts of compensators are similarly shown and dimension drawings of motors and compensators are furnished.

LUNKENHEIMER "Renewo" valve, a renewable seat, regrinding valve adapted for high pressures, is described and illustrated in a booklet recently received. All parts are renewable, particularly the seat and disc, which, being subjected to the greatest wear, are made of a high nickel alloy.

Copies of the booklet can be had upon request to The Lunkenheimer Co., Cincinnati, O.

CHAIN GRATE STOKERS is the title of a book recently received from the Babcock & Wilcox Co., which discusses the subject of automatic stokers and describes in detail the Babcock & Wilcox chain grate stoker, pointing out its many excellent qualities and giving results of a number of tests which have been made upon boilers equipped with these stokers.

MESTA ROPE DRIVES are described and illustrated in Bulletin O, from Mesta Machine Co., Pittsburgh, Pa.

DRAWING THE CROWD and Keeping It, is the title of a pamphlet devoted to Westinghouse flame-carbon arc lamps, rectifier outfits, electric fans and other Westinghouse electric equipment.

DETAILS OF complete piping installation and illustrations of Taylor spiral riveted pipe in use, are given in Bulletin 14-4 from American Spiral Pipe Works, P. O. Box 485, Chicago.

HOW TO TAKE OIL out of boiler feed water is discussed in Bulletin No. 89, on Elliot grease extractors applied to pumping stations. The manufacturer is Elliott Co., 6910 Susquehanna St., Pittsburgh, Pa.

ROTARY METERS for the measurement of steam and all artificial and natural gases under low or high pressure, are the subject of a pamphlet from Rotary Meter Co., 280 Broadway, New York.

A MANUAL of Electrical Testing, Bulletin 104 relating to Wagner portable instruments, was recently received from Wagner Electric Manufacturing Co., St. Louis, Mo.

SPRAGUE ELECTRIC WORKS of General Electric Co. has issued the following pamphlets: No. 905, describing Sprague electric hoists; No. 331, on Sprague electric fans; No. 441, on Sprague watertight floor boxes; Nos. 950, 951, 952 and 953, on theatrical devices.

SCALE REMOVAL in Fire-Tube Boilers is the name of a new bulletin just issued by the Lagonda Mfg. Co., Springfield, O. This descriptive and illustrated bulletin presents the company's line of improved fire-tube boiler cleaning apparatus, and its lately developed turbine-driven clover shape vibrator knocker head. Copies may be had on request.

INGERSOLL-RAND CO., 11 Broadway, New York City, has ready for distribution a limited number of books, "Photographs in Color of the Panama Canal," illustrating the dams and locks in natural color, and supplemented with a concise article on What the Canal Will Accomplish, by Emory R. Johnson. A copy will be mailed free on request.

FROM THE BRISTOL CO., Waterbury, Conn., we have lately received the following:

Bulletin 188, the Patented Spring Type Bristol's recording differential pressure gage, equipped with diaphragm or helical type pressure tubes and a patent frictionless sleeve. Bulletin 189, the Patent Float Type of Bristol's recording differential pressure gage, in which no springs are employed.

These gages are particularly valuable for use in connection with orifices, Pitot tubes and Venturi tubes for measuring and recording rate of flow of air, gas, steam, water and other liquids.

TEXTILE QUARTERLY No. 7, recently issued by the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., deals with the equipment of power plants of textile mills. The construction and operation of the turbines are thoroughly explained and illustrated, and the advantages of that method of drive for industrial plans are clearly explained. Several tables are devoted to the figures showing the comparative cost of installation of reciprocating engines, low-pressure and high-pressure turbines, and high-pressure turbines with bleeder.

STEAM SUPERHEATERS is the subject of the book recently published by the Babcock and Wilcox Co., which is a comprehensive treatise of the subject of superheated steam and superheaters. Starting with the history of the use of superheated steam for power plant machinery, the authors follow this with a chapter on the properties of superheated steam, giving the results of some of the latest experiments and investigations which have been made. Advantages of the use of superheated steam are then pointed out and detailed descriptions of the Babcock & Wilcox superheaters as applied to several types of boilers are given.

AN INTERESTING BOOK on "Condensers and Auxiliaries" is issued by the C. H. Wheeler Mfg. Co., of Philadelphia, Pa. A glance at the table of contents will show the ground covered as follows:—Economy of high vacuum; thermodynamics of the condenser; jet condenser; surface condenser; vacuum pumps, including the Mullan displacement, the Pratt rotrex, rotative dry vacuum, and Thyssen entrainment; circulating pumps, including centrifugal and direct-acting. There are also chapters on feed water heaters, exhaust connections and water cooling towers. The data given shows the water needed per pound of steam condensed for different temperatures of cooling water and vacuums, explains the arrangement of steam inlet and disposition of tubes for surface condensers, and illustrates and fully explains the details of the different condenser, pump and cooling tower apparatus manufactured by the C. H. Wheeler Mfg. Co. The book has 130 pages, of 6 by 9 size, and is in substantial cloth binding. It can be had by application to the Philadelphia office of the company.

Trade Notes

WESTINGHOUSE ELECTRIC & MFG. CO. reports the receipt recently of orders for the textile industry totaling 217 a.c. motors, aggregating 4546 hp., among which are the following: Waltham Bleachery and Dye Works, Waltham, Mass., 13 motors, totaling 400 hp.; Lowell Bleachery, Lowell, Mass., 3 motors, totaling 100 hp.; River Spinning Co., Woonsocket, R. I., 7 motors, totaling 230 hp., and 2 37½-k.v.a. transformers with 1 3-panel switchboard; Shetucket Co., Norwich, Conn., 6 motors, totaling 105 hp.; American Mills Co., Waterbury, Conn., 16 1-hp. loom motors with 16 textile type switches; Clifton Textile Co., Weehawken, N. J., 9 motors, totaling 95¼ hp.; John H. Meyer & Co., Bloomsburg, N. J., 1 75-k.v.a. turbo generator unit, exciter with 1 3-panel switchboard, and 4 motors totaling 35 hp.; J. & J. Dobson, Inc., Philadelphia, Pa., 1 470-k.v.a. low-pressure turbo-generator unit, 1 Westinghouse-LeBlanc barometric condenser; 2 motors totaling 500 hp., 1 25-kw. tur-

bine-driven exciter, 1 16-kw. motor-generator exciter set, and 1 6-panel switchboard; Pennsylvania Textile Co., York, Pa., 1 562-k.v.a. belted a.c. generator; 1 22½-kw. belted exciter, and 23 motors totaling 600 hp.; The Barnesville Mfg. Co., Fairmont, W. Va., 10 motors totaling 90 hp.; Norfolk Collar and Pad Co., Norfolk, Va., 11 motors totaling 134 hp.; Cliffside Mills, Cliffside, N. C., 1 375-k.v.a. turbo-generator unit with exciter, 1 125-k.v.a. turbo generator, 1 18-kw. generator, 2 motors totaling 480 hp., and 1 4-panel switchboard; Brown Mfg. Co., Concord, N. C., 10 motors totaling 290 hp., 6 oil circuit breakers, and 4 auto-starters; Lang Mfg. Co., West Point, Ga., 13 motors totaling 275 hp., 3 100-k.v.a. 11,000-v. transformers, 1 15-k.v.a., 11,000-v. transformer with 1 3-panel switchboard, and 1 set electrolytic lightning arresters.

ENGBERG'S Electric & Mechanical Wks. reports the receipt of Government contracts, covering 19 direct-connected generating sets, together with 11 switchboards.

TERRY STEAM TURBINE CO., of Hartford, Conn., reports one of the largest month's business in its history, and the installation of additional machine tools, increasing the capacity of its plant approximately 25 per cent.

ON ACCOUNT OF the large volume of business which it is receiving, and which has been offered to it, the Skinner Engine Co., of Erie, Pa., has decided to do away, if possible, with night work, and to this end has let contracts for extension of its shops and for additional machinery.

FOR USE ON GASOLINE systems, the Thread-Tight Co. of 2 Rector St., New York City, is placing on the market a gasoline paste called "Gasoltite" for use on threaded connections or on flanges in connection with gaskets. It is claimed that this paste is gasoline proof and will not harden, so that there is no trouble in taking joints apart.

THE C. & G. COOPER CO., Mt. Vernon, O., is shipping to the Columbia Gas & Electric Co.'s Branchland, W. Va., Pumping Station, 2 compressor units consisting of 21½ by 36-in. single tandem Cooper gas engines, direct driving 15½ by 36-in. Ingersoll-Rand Hurricane type compressor cylinders. These 2 units will deliver about 14,600,000 cu. ft. of free gas per 24 hr., against a pressure of 275 lb. The company is building for the Logan Natural Gas & Fuel Co. a 24 by 48 Twin tandem compressor unit, which will also drive Ingersoll-Rand Hurricane type compressor cylinders, to be installed at the Pavonia, O., Pumping Station of the Logan Co. The Altoona Portland Cement Co., Altoona, Kan., has ordered a 21 by 30 single tandem Cooper gas engine, to be d.c. to an a.c. generator. This machine is to operate in parallel with other gas engine units. The Marshall Field Estate has just placed an order with the company for 3 Corliss steam engines. These are to furnish light and power for the Conway Bldg., Chicago. This order covers one 16 by 36 Simple Corliss engine d.c. to a 200-kw. generator, 1 24 by 42 d.c. to a 400-kw. generator, and one 24 by 40 by 42 cross compound noncondensing Corliss engine, d.c. to a 600-kw. generator.

PRACTICAL ENGINEER

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WANTED—ALL STEAM USERS to have clean boilers without using compounds or chemicals in any form. Write "Otis," No. 317 Norfolk Ave., Buffalo, N. Y. tf.

WANTED—Secretary of local Engineers' Association to write at once in regard to a very interesting proposition. Address Practical Engineer, Circulation Department.

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MR. ENGINEER—If you are tired of the daily rut of your job, and are ambitious to make a way for yourself in the selling end of the engineering line, we have something unusual to offer you. Become a sales engineer and earn three to six times as much as your present salary. You can do it without any risk whatsoever, but you must possess certain qualifications. Write us and we will tell you if you are elegible. We manufacture boiler appliances of the highest merit and standing, selling as high as $400 per boiler, and yielding in commissions as high as $100 per boiler. One sale may mean more than your week's salary. Write us. Box 349, Practical Engineer. tf.

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TRAVELING CRANE—Wooden—For Sale Cheap. 15-ton capacity, 65-ft. span, suited for either motor or wire rope drive. Write Box 346, Practical Engineer. 4-15-6

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FOR SALE—2 Buckeye steam engines at bargain prices. One 12 by 21-in., 85-hp., 185 r.p.m., 85-lb. steam pressure, flywheel 6 ft. diameter, 22-in. face. One 11 by 18-in., 70-hp., 200-r.p.m., 85-lb. steam pressure; flywheel 4 ft. diameter, 14-in. face. Changed to motor drive. Must move at once. Write today The W. H. Mullins Co., Dept. A, Salem, Ohio. 4-15-6

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PATENT YOUR INVENTION. Send sketch for free expert search and report as to patentability. Books on inventions and patents, and book of references from congressmen, manufacturers, bankers and inventors sent free. John S. Duffie & Co., 612 F St., N. W., Washington, D. C. tf.

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Sparks From The Advertising Pages

Ordinarily, the army recruiting offices in our large cities are rather dull places, generally being distinguished by a yawning, sleepy sergeant standing sentinel at the entrance and a still sleepier commissioned officer and doctor in the office.

However, when there is a prospect of war, they are the busiest of places. On the day after our sailors landed at Vera Cruz, the Chicago recruiting offices were crowded with men of all ages, sizes and colors, eager to enlist. Boys misrepresented their age, veterans of three United States wars wanted to enlist; a company of Greeks, fresh from the Balkan war, offered their services,—even a company of women wanted to serve in the cavalry.

It doesn't take much to kindle the spark of patriotism in the American breast. From our birth on we are inculcated with the teaching that this is the land of Liberty, and whenever this Liberty is threatened, our fighting spirit is aroused.

And it doesn't take long to make an American at heart out of those who immigrate here from other countries. Long before they reach our shores, they have learned of this country of freedom and opportunity. The stories of the Declaration of Independence, the Constitution and the Emancipation Proclamation are printed in other languages and advertise America as the hope of the oppressed.

We lose no opportunity to advertise our country as the home of Liberty. A colossal bronze statue of Liberty Enlightening the World is the first impressive sight in New York harbor. Our coins are imprinted with the symbolic head of Liberty. And our National anthems make frequent allusions to it.

Should the newcomer reach here unimpressed by the legendary and historical lore attending the birth and growth of America, we have in reserve, Independence Day, wherein the whole land is ablaze with patriotism.

The man is poor in soul indeed who, after observing and participating in the patriotic celebration of July 4th, does not have a warmer feeling for the country which emerged from the meeting in Independence Hall, July 4th, 1776.

"The Fourth" is the annual advertisement of the country's bulwark to its people.

It implants the germ of patriotism in the boy, transmits it to the immigrant and rejuvenates it in the rest of us.